David Rios Insua
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Editors

Advances in Group Decision and Negotiation 5

e-Democracy

A Group Decision and Negotiation Perspective

Springer

e-Democracy

Advances in Group Decision and Negotiation

Volume 5

The book series, Advances in Group Decision and Negotiation — as an extension of the journal, *Group Decision and Negotiation* — is motivated by unifying approaches to group decision and negotiation processes. These processes are purposeful, adaptive and complex – cybernetic and self-organizing – and involve relation and coordination in multiplayer, multicriteria, ill-structured, evolving dynamic problems in which players (agents) both cooperate and conflict. These processes are purposeful complex adaptive systems.

Group decision and negotiation involves the whole process or flow of activities relevant to group decision and negotiation – such as, communication and information sharing, problem definition (representation) and evolution, alternative generation, socialemotional interaction, coordination, leadership, and the resulting action choice.

Areas of application include intraorganizational coordination (as in local/global strategy, operations management and integrated design, production, finance, marketing and distribution – e.g., as for new products), computer supported collaborative work, labor-management negotiation, interorganizational negotiation (business, government and nonprofits), electronic negotiation and commerce, mobile technology, culture and negotiation, intercultural and international relations and negotiation, globalization, terrorism, environmental negotiation, etc.

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Foreword

In group decision and negotiation (GDN), we seek solutions – jointly decided actions – to group problems. With *e*-democracy, the GDN solution process involves application of GDN concepts, democratic principles, and technology that can extend democracy to a higher level of participation with increased potential for problem solutions that produce connectedness among participants.

How the GDN approach and *e*-democracy can mutually reinforce each other is at the heart of this noteworthy book. Thus we have a jointly emerging hybrid – GDN/*e*-democracy – that is well represented in the editors' overviews in Chapter 1 and 19, and by the contributions of the various authors. These concern political, methodological, technical bases, and case studies of *e*-democracy. The book is a welcome addition to the ongoing book series, *Advances in Group Decision and Negotiation*.

The world has many difficult problems. GDN/*e*-democracy can help find solutions that the world badly needs. This book arrives at an opportune time – now.

That is all that is needed for this foreword; the rest is in the book.

New York, NY Melvin F. Shakun

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We are grateful to the authors of the various chapters. Taken together, they provide a wide-ranging and very original, refreshing panorama of *e*-democracy, showing that it is something more than *e*-debating and *e*-voting. The conscientious advice of the referees made our work much simpler. Mel Shakun kindly asked us a few years ago to prepare this monograph and, even more, has prepared a wonderful prologue for our volume. In between, the personnel at Springer have been exceedingly patient with our continuing delays.

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Last, but far from least, our families – Susana, Sabela, and Ota; and Judy, Kate, and Sarah – have been extremely supporting, especially as other pressures, often institutional, political, and not a little trying, also took our time.

It is our fervent wish that rationality, participation, and deliberative democracy in the spirit embodied in the pages that follow would permeate society and our institutions. Supported by technology, such a spirit of inclusiveness might release us from the current closed door machinations that are still to be found framing much of our lives.

Madrid
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Part I
Political Bases

Chapter 2
Concepts in Democratic Theory

Manuel Arenilla

2.1 Introduction

Few words exist in the social sciences that have so many different, even opposed, meanings and that have mobilized more passion and people throughout history than that of democracy. This word evokes not only hope but also apathy; it represents the future although also a profound past; it symbolizes change as well as resistance to change; it excites passions, but produces conformity. As if it were a sun, around this concept others revolve structuring the political and social essence of contemporary life: liberty, equality, power, sovereignty, representation, participation, legitimacy, choice and the common good.

The concept of democracy just reflects the evolution that has taken place over the last two and a half millennia of a system for the organization of the exercise of political power in society, which includes diverse and contradictory meanings. It is a creation of Western thought, with innumerable theoretical and ideological contributions and political forms exercised over this time. The fact that it is a historical and cultural product, as well as a social model, explains current problems related with attempts to extend it to certain societies, as their context is too different from those in which the concept of democracy was forged.

What we know as democracy today is grounded in the theoretical premises of democratic liberalism, which has little or nothing to do with the Athenian democracy. Its construction owes much both to its detractors and to its defenders. It represents a specific type of society that can be contrasted with all other political systems and with what in each historical moment, since Athens, has been understood as democracy. In addition, democracy today has become a "brand" or a "certificate of quality" for states in international relations.

The evolution of democracy is in debt with the development of the concepts of liberty and equality. Democracy has been constructed on these two principles and

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they constitute the explanatory core of the ideas developed in this chapter, which are based on the classics of political theory. Constructing the evolution of the concept of democracy based on participation or its limitations is a tempting offer, particularly in a book of these characteristics. Contrasting the exercise of direct power with the exercise of power through representation restricted by an institutional structure has great explanatory power, but such a focus could divert the discussion of the essence of democracy toward a quantitative question, government by the many or by the few, present today in the debates around *e*-democracy. Thus, the central theme of democracy has to be found in the meaning of political power, in the nature of the citizen and his/her role in society and in political institutions. It is the opposition between the individual/citizen and the exercise of power which gave rise to the evolution of the concept of democracy.

This chapter deals with what is understood by democracy. From the focus just mentioned, we will begin with the principles of liberty and equality and look at the concepts of direct democracy, representative democracy and participatory democracy. Lastly, we will look at some of the principal elements of the crisis in democracy and the challenges that it currently faces.

2.2 What Is Democracy

As mentioned, the development of democracy is in debt to the evolution of the concepts of liberty and equality. These concepts had very different meanings in ancient democracy in comparison with how they are understood today. Under ancient democracy, liberty meant to live as one wanted to, in principle, not be governed by anyone, or if so, to govern in turn, that is, "for all to rule and be ruled in turn" (Aristotle, 1988). This idea of liberty as no dependence, as autonomy, was completed with another essential aspect, which was the attainment of the social status of citizen by man, which permitted him to participate in governing the state, in the exercise of collective power (Sartori, 2003). Liberty existed before the law; it had a collective character and was compatible with "the complete subjection of the individual to the authority of the community" (Constant, 1988). This concept of liberty was only possible if it was based on equality among citizens.

Equality for the Greeks was not absolute. It rather referred to political rights and participation in common affairs. To arrive at this concept, it was necessary to conceive all men as possessing the capacity for autonomous political judgment and political competence, which entailed the possibility of their equal participation in public affairs and a link between this participation and honour and justice. This equality, in turn, involved the right to demand participation in the management of the affairs of the polis. Plato (1986) wrote that it corresponded to all men to take part in political virtue "or cities cannot exist". Aristotle (1988) wrote that for there to be equality, "it is just for the poor to have no more advantage than the rich; and that neither should be masters, but both equal". In this way, he sentenced the main defect of Greek democracy, even condemning for centuries the very word democracy. Lastly, he stated that democracy distributes equality among both equals and unequals (Aristotle, 1988).

All this can be summarized by pointing out that, for the Greeks, the concepts of liberty and equality were inseparable from the notion of citizen and that man achieved such a condition as he participated in the political life of the city, as it was that participation which made him a citizen, and not the contrary (Sartori, 2003). Thus, Aristotle said that "the state is, by nature, clearly prior to the family and to the individual, since the whole is of necessity prior to the part" (Aristotle, 1988). In this conception, the political was opposed to the private or the personal and referred to what was in common, to what was of concern to all (del Águila et al., 1998), and participation was not an element of democracy but rather its very foundation. In this way, for Aristotle the "political" was nothing other than government of the free and equal (Aristotle, 1988).

The critics of pure or classical democracy carried out a dialogue about it for centuries which led to the republican focus (Held, 2006). It had such an impact that the word "republic" replaced the word "democracy" up until almost the nineteenth century. The republican focus was on constructing a popular government that would not reproduce the "evils" of government by the many, or the poor, as Aristotle said, and found it in the mixed government that first appeared in Republican Rome and later in the Italian republics and Rousseau's Geneva. As in the Greek case, the origin of the republican focus was found in the very conception of man. If for classical democrats all men possessed equal capacities for autonomous political judgment and political competence, which permitted them to participate in the government of the polis, for the first republicans it was the polis which gave form to the citizen, who was seen as lacking capacity, through the law (Held, 2006) and educated him in virtue dictated, in the case of Plato, by the philosophers. For Madison, the two most important differences between a democracy and a republic were, first, that in a republic "the delegation of power to a small number of citizens chosen by the rest" (Held, 2006) and, secondly, "the greater number of citizens and the greater dimension of the country over which the republic can extend" (Rivero, 1998). Both these points are the basis for the preference for representative over direct democracy.

In addition to these differences, there existed similarities between the concepts of democracy and republic that would nourish modern democracy. Both the model of Greek democracy and the diverse republican models coincided in considering man as a social and political animal who develops his potential in a political community. They both focused also on the need for citizens to place the common good before private interest in order to preserve the political community and defend liberty. Both conceptions coincided on the value of not only political, but social, equality, which included a certain equality of wealth to avoid the appearance of factions. Lastly, they shared a similar conception of citizenship, understood as an intense participation in the political life of the community and tied to an idea of liberty that referred to status (of the citizen) and autonomy in relation to that community and its institutions (Rivero, 1998).

In contrast to this understanding of liberty and equality by the ancient Greeks, we find that of liberal democracy. For the liberals, "The only freedom which deserves the name, is that of pursuing our own good in our own way, so long as we do not attempt to deprive others of theirs, or impede their efforts to obtain it" (Mill, 1986). Liberty is the right not to be subject to other than the law "and must consist of peaceful enjoyment and private independence" (Constant, 1988). This subjection to the law affects, mainly, to power itself in such a manner that "power should be a check to power" (Montesquieu, 1989). When they form part of society, men renounce to their inherent equality, liberty and executive power and leave them all in hands of society, which regulates it through its legislative power by means of laws addressing the common good of society. What man obtains through this renouncement is the preservation of himself and his property (Locke, 1986). This permits Marx to state that "the practical application of man's right to liberty is man's right to *private property"* which constitutes the foundation of the bourgeois society (Marx, 2004).

In contrast to the classical conception, there is a clear dominance of individual liberty over the political liberty of participation in collective affairs, which is deemed of secondary importance. Liberty must include the lack of interference of the state so that citizens can enjoy their privacy in peace (Constant, 1988). Liberty implies the dominion of internal conscience, freedom in our taste, and in the determination of our own aims, and freedom of association (Mill, 1986).

The equality of the liberals was basically an equality of rights, but its formal expression presented serious difficulties because of the fear that the extension of political rights could alter property rights. It seems clear that for effective limits on political power, which protect individual liberty and the shaping of the common good or general interest, it is necessary that there is political equality and a certain economic equality (Held, 2006); however, political equality would not be formally guaranteed until the establishment of universal suffrage at the beginning of the twentieth century.

For Rousseau, liberty prevailed only under no serious social and economic imbalances, understanding by this that all citizens participate under the same conditions and enjoy the same rights (Rousseau, 1967). Lastly, for Marx, liberal equality "is nothing but the equality of the *liberté* described above – namely: each man is to the same extent regarded as such a self-sufficient monad" (Marx, 2004).

In this way, under liberalism the conception of liberty and equality fundamentally preserves individual liberty and natural rights in relation to the state and the collective, without undervaluing participation, although this clearly is secondary to the mechanism of representation. It is both the limits placed on power in relation to individual rights and the separation of powers which shape liberal institutions which conclude in representation and have come to be central to what we understand today as democracy. For liberalism, society is born from the individual's renunciation of his/her natural liberty with the aim of obtaining more favourable civil liberties. Liberalism's emphasis on individual liberty would inhibit the extension of the principle of political equality, which would lead to revolutionary outbreaks in Europe from the middle of the nineteenth century until the beginning of the twentieth century.

The focus of liberalism has been the object of numerous critiques from diverse perspectives until today. We will focus on three particular issues which have been raised. The first is the confrontation between individual freedom and the collective interest; the second is the conflict between representation and popular sovereignty;

the third, the opposition between the individual and the community. The first issue refers to how the common good or general interest is shaped in a society of free individuals. Rousseau contrasted individual will with the general will. For him, the individual will referred to private interest, while the general will was the common interest of the political community and of each of its parts (Held, 2006). Contrary to Rousseau, Schumpeter denies the existence of such a general will, not to extol individual will, but rather because he understood that no common good, equally discernible by all, exists.

The second issue derives from the previous one and can be raised in the terms used by Constant (1988), who, contrasting the liberty of the ancients with that of modern thinkers, said that the first "admitted as compatible with this collective freedom, the complete subjection of the individual to the authority of the community" so that "the authority of the social body interposed itself and obstructed the will of individuals." For Rousseau, this type of subjection is not possible as the people are sovereign in actively participating in the articulation of the general will (Held, 2006). For his part, Marx did not accept the existence of both a public and a private nature, as for him the rights of man were the rights of a member of the bourgeois society, of the egoistic man, of the man separated from the other men and from community (Marx, 2004), which would lead him to demand unity between the civil and the political society. For Marx (2004), bourgeois rights were summed up in the right to property, which was understood as an individual freedom independent of society.

The dichotomy between the individual and the collective would mark the two major tendencies of liberalism. For some, like Bentham or James Mill, individual liberty had to be protected from the state and other citizens so that the individual could develop his private life, participation being merely of instrumental value (Held, 2006). For others, such as John Stuart Mill, political participation had an intrinsic value and was seen as a fundamental mechanism for moral self-development and the protection of individual interests (Held, 2006).

The criticisms to political representation are the most numerous. Rousseau was opposed to any representation mechanism because, as he understood, "It is against the natural order for the many to govern and the few to be governed" (Rousseau, 1967) and that when citizens choose their representatives, they become slaves (Rousseau, 1967). Rousseau's magistrates were chosen, but they did not represent the people, as the people did not renounce their power (Sartori, 2003). For his part, Marx rejected as legitimate any other form that was not direct democracy and defended the binding mandate for those elected and the principle of recall and the permanent responsibility of all civil servants and public officers (Marx, 1966). However, the main criticism to political representation by numerous and diverse authors stems from the assertion that government in modern democracies is exercised by a minority, which means that it has not managed to avert the danger of factions that concerned early liberals very much (Held, 2006). What these diverse thinkers are not in agreement is on the possibility of this changing. The elitists are sceptical while the Marxists defend the possibility of a government for all. Thus Michels (1962) wrote that "[T]he mass will never rule except *in abstracto*" concluding that democracies “undergo gradual transformation, adopting the aristocratic spirit” (Michels, 1962). Schumpeter stated that “democracy means only that the people have the opportunity of accepting or refusing the men who are to rule them” as democracy is a very limited method for the selection of politicians who accede to power competing for the vote of the people (Schumpeter, 1976). He also stated that “the will of the people is the product and not the propelling power of the political process.” Along similar lines, Dahl (1998) refers to current democracies as polyarchies, which permit stable governments and in which decisions are adopted by a technocracy without interference from the people, which leads him to conclude that democracies are what they must be.

2.3 Direct Democracy

For centuries the word democracy only meant government directly exercised by citizens. The concept became tied to a political system which, for its excesses, was seen as so undesirable that for a long time the word democracy was not used, replaced by the word republic. The history of direct democracy shows us that this type of government is very rare, limited almost exclusively to ancient Greece and some concrete experiments, such as the Jacobin stage of the French Revolution and the Paris Commune. The rest of history’s democratic phenomena fit, up until now, within the parameters of representative democracy. This does not mean that the study of direct democracy makes little sense, as it functions as a utopian reference with which to compare the functioning of representative democratic institutions. Currently, the study of direct democracy is stirring new interest due to the possibilities that information and communication technologies offer, permitting us to talk about *e*-democracy. Some radical movements, particularly those that emphasize citizen participation, contain some of the key elements of direct democracy.

Direct democracy is based on the equality of all citizens and its characteristics can be extracted from ancient democracy. No one is better than Aristotle to summarize these (1988):

1. Officers are chosen among all, including the administration of justice.
2. Offices which do not require experience and skill are rotated by lot, of short duration and cannot fall on the same person twice.
3. Occupation of offices does not depend on income.
4. Officers receive a salary.
5. The assembly has authority over all affairs or over those of major importance.

Constant (1988) synthesized the functioning of direct democracy in pointing out that it “consisted in exercising collectively, but directly, several parts of the complete sovereignty; in deliberating in the public square about war and peace; in forming alliances with foreign governments; in voting laws, in pronouncing judgments; in examining the accounts, the acts, the stewardship of the magistrates; in calling them to appear in front of the assembled people, in accusing, condemning or absolving them.”

Despite its conceptual prestige, which would lead Marx, when studying the Paris Commune, to state that the institutions of direct democracy were the only legitimate ones (Marx, 1966), direct democracy had powerful enemies from its beginning. These based their opposition on three major criticisms. Thus, Aristotle (1988) identified the weakest point of direct government by the people and stated that it is really a government by the poor as they are the majority of the citizens and, therefore, they impose themselves over the minority. Along the same lines, Mill (1991) considered direct democracy to mean the exclusion of minorities, in concrete, the most educated and those with the most wealth. For his part, Constant (1988) made the second important criticism of direct democracy – the complete subjection of the individual to the community, which implies the loss of personal freedom when it does not serve the collective. These two criticisms, together with the clear excesses produced during several revolutionary periods, such as the Jacobin stage of the French Revolution or the Paris Commune, eliminated the possibility that direct democracy would today be something more than just a yearning of radical democrats.

The third criticism questioned if the majority of citizens were capable of understanding with sufficient criteria the governmental decisions and actions. Machiavelli saw the majority of men as selfish, lazy, suspicious and incapable of doing something good if it was not as a result of necessity (Held, 2006). Montesquieu said that "The great advantage of representatives is their capacity of discussing public affairs. For this, the people collectively are extremely unfit, which is one of the chief inconveniences of a democracy," which here, logically, has to be understood as referring to direct democracy (Montesquieu, 1989). Precisely, the liberal authors tried to avoid the evils of classical Greece, impeding in their theoretical constructions that the people take active part in decision making, considering them to be completely incapable, concluding that "They ought to have no share in the government but for the choosing of representatives, which is within their reach," limiting their capacity specifically to choosing their representatives (Montesquieu, 1989). The logical outcome of this perspective was the distrust toward the less educated classes and less wealthy classes acceding to representation, as they could alter the rights of property. This led them to support limited suffrage. Another effect was the appearance of a growing bureaucratic apparatus responsible for the technical tasks of governing.

Together with these criticisms, we should add those referring to the effectiveness of direct democracy. All liberals agreed that such a system was only valid for a small number of citizens and for a small country and that, in any case, a large country would better guarantee the common good (Hamilton et al., 2005). Schumpeter understood that direct democracy was not desirable because of its inadequacy for the necessities of governing states which must resolve a great number of complicated technical problems.

Anyway, from direct democracy two key ideas have survived: that popular government is the only legitimate one and that citizen participation is essential for the continuity of the state and society. The debate around *e*-democracy brings direct democracy and its criticisms up-to-date and allows us to reconsider them in the light of new technologies and new economic, political and social mechanisms, so different from those of two centuries ago.

2.4 Representative Democracy

We should first note that, with the exception of certain shared terminology, representative democracy has little to do with direct democracy. This is not only due to the radical differences in the entailed meaning of the terms citizenship, liberty, equality and sovereignty, but also because representative democracy introduces a series of mechanisms and institutions that try to achieve a balance between the exercise and control of power. Among these, the most important are the division and separation of powers and a certain constitutional engineering that establishes limits on the actions of the state and guarantees the protection of basic individual rights in relation to the state. The aim is to avoid a concentration of power in a majority faction and achieve a balance between different powers.

We should stress, additionally, that representative government was constructed in opposition to direct democracy and its characteristics, particularly political equality. Thus, Dahl (1998) points out that representative democracy promotes a high degree of political equality. Representative democracy is the application of the logic of equality to large communities, which profoundly transforms the significance and reach of that equality. For many authors, direct government by the citizens was the ideal as a political system, although it was often seen as unreachable or problematic and could generate excesses. Thus, for Mill "the only government which can fully satisfy all the exigencies of the social state is one in which the whole people participate." However, he recognized that in communities with more than a small population "the ideal type of a perfect government must be representative", as it would permit the participation of all the citizens and form better persons (Mill, 1991). Beyond the issue of the immensity of modern states, the decrease of love of one's country, the actions of private interest and the conquests and abuse of government should be added (Rousseau, 1967). All this led Jefferson to conclude that representative democracy was the democracy that was most practicable over a long period of time and over a large territory (Dahl, 1998).

Representative democracy is also justified over political systems other than direct democracy. For Mill (1991) "the rights and interests of any person are only secure from being disregarded when the person interested is himself able, and habitually disposed, to stand up for them" which leads to the growth and spread of general prosperity.

Along with a different conception of equality and citizenship, representative government also gives a different meaning to sovereignty. In contrast to the unlimited sovereignty attributed to the citizens in the conception of direct democracy, which is summarized by Rousseau (1967) as "Sovereignty, for the same reason that makes it inalienable, cannot be represented", although he was thinking of small states, we find a contrary position among the defenders of representation. Thus, Constant would defend the idea that the sovereignty of people only exists in a limited and relative way, given that where independence and individual existence begin, the jurisdiction of this sovereignty ends. He would maintain that not understanding this limit would introduce into human society "a degree of power which is too great to be manageable and one which is an evil whatever hands you place it in" (Constant, 1970), and the way to avert it was through the representative system, which "is nothing but an organization by means of which a nation charges a few individuals to do what it cannot or does not wish to do by herself" (Constant, 1988).

For Dahl (1998), the political institutions of democratic representative government today, which constitute a new form of popular government that never existed before and are due, in part, to demands for inclusion and participation in political life, are the following:

1. Elected officials.
2. Free, impartial and frequent elections.
3. Freedom of expression.
4. Autonomy of association.
5. Alternative sources of information.
6. Inclusive citizenship.

Criticisms of representative democracy are numerous and focus on diverse aspects. Here, we will look at two: the relationship between the majority and minorities and the composition of the common good. The first criticism is that representative democracy forms "a government of privilege, in favour of the numerical majority, who alone possess practically any voice in the State" (Mill, 1991). This position has resulted in the strengthening of the small number of representatives which has culminated in the appearance of modern political parties with their tight control of political and even social life. At this point, the problem shifts from being that of government by the many to government by the few, something which Machiavelli had tried to avoid in stating "when people are entrusted with the care of any privilege or liberty, being less disposed to encroach upon it, they will of necessity take better care of it; and being unable to take it away themselves, will prevent others from doing so" (Machiavelli, 2003).

For his part, Michels (1962) stated that "the government, or, if preferred, the state, cannot be anything other than the organization of a minority. It is the aim of this minority to impose upon the rest of society a "legal order," which is the outcome of the exigencies of dominion and of the exploitation of the mass of helots by the ruling minority and can never be truly representative of the majority. The majority is thus permanently incapable of self-government. Thus, the majority of human beings, in a condition of eternal tutelage, are predestined by tragic necessity to submit to the dominion of a small minority, and must be content to constitute the pedestal of an oligarchy." However, this does not mean that Michels completely renounced all effort to place limits on the powers exercised over the individual by the oligarchies: "It would be an error to abandon the desperate enterprise of endeavouring to discover a social order which will render possible the complete realization of the idea of popular sovereignty." In this way, the critics of representative government pointed out that this avoids the excesses of a government of the people only to culminate in the periodic election of representatives that come from one or more groupings of elites or which pertain to a single class.

The second criticism starts from the very conception of the citizen, which comes from the theories of liberalism, shared in part by earlier authors such as Aristotle. For many of them, the citizen was not capable by himself of reaching a high level of motivation as he was basically mediocre, which impeded him to search for the common good, the ultimate aim of government. Some authors stressed the need to educate the citizens, so that they could fully participate in the search for this good, but others saw them as apathetic or took elitist positions, such as that of Schumpeter (1976) who negates the existence of this common good. In this way, for some, the search for the common good was relegated to those most capable, an elite currently composed of elected representatives, administrators, bureaucrats, judges and international organizations, which would first justify limited suffrage during more than a century and then lead to the exercise of enormous discretional power and deal-making between political elites and bureaucrats (Dahl, 1998). This widespread position places in doubt whether representatives really look for the general interest, except when this is the sum of diverse private interests that intervene in political decisions. Radical democrats maintain the position that they fear government by the few more and see the common good as coinciding with the good of the people. Marx represented a more extreme version of this position when he stated that liberal rights, particularly those of property, made individuals retreat into themselves and dissociate from the community and this would impede them from reaching their social being (Marx, 2004).

2.5 Democracy and Participation

From the beginning, theorization on democracy has been indissolubly linked to the concept of citizenship and this, in turn, to that of participation, to the point that the strength of this connection is what structures the two major contemporary trends in democratic theory: that which understands participation as its defining element and that which, though valuing it, subordinates it to representation.

For the ancient Greeks, the nature of the citizen was defined more by his participation "in the administration of justice, and in offices" than by any other characteristic so the citizen was "he who has the power to take part in the deliberative and judicial administration" in such a manner that the body of such self-sufficient persons was referred to as the city (Aristotle, 1988). For the Greeks, political organization referred to the body of free, equal and self-sufficient persons who were shaping common life through their participation. Thus, private life could not be distinguished from common life, nor the citizen from his city. All human beings possessed the same political virtues, so that an individual that did not participate in the life of the community, where one obtains honour and justice, would have been considered a useless person (del Águila et al., 1998). The Greek concepts of equality and liberty granted independent status to the citizen which permitted him to have a certain position in the community, so that equality and liberty had only meaning if they referred to participation in the government.

As we have seen, Athenian democracy relegated individual liberty and government of the most capable in favour of the control of the collective over the individual, whose liberty could be taken away invoking the will of the majority. The result was tyrannical and unstable governments, which, in response, gave rise to republican thought, to the Roman Republic and, later on, to the Italian republics which tried to correct these excesses through a government mixed or balanced between leaders and the participation of the people who were seen as the guardians of liberty (Machiavelli, 2003).

Today, participation continues to be a point of polarization over the understanding of democracy. For some, democracy cannot be understood without referring to the Athenian ideal, tempered by republican thinking. For others, democracy is based on the strengthening of the representative system, after taking into account the weaknesses of the institutional model designed by the liberals.

The excesses of Greek democracy and its sequels, particularly the Jacobins, generated strong theoretical antibodies among the liberals that were justified by the great size of the new states and the deep social inequalities existing in liberal societies. Although they continued to consider taking part in government as being important, they stressed private independence. The new political order had to guarantee privacy, individual liberty and private property in relation to the state, although this might result in the danger of renouncing "[the] right to exercise some influence on the administration of the government" (Constant, 1988). It must be mentioned that participation was presented as an individual right and not as the true meaning of political life, which was the representative government, where the representatives were those with knowledge and property.

The fear of the excesses of the many, which were characteristic of direct democracy, meant that participation was relegated to an expression of political equality. This, despite the original intentions of the theoretical liberals, resulted in limited suffrage, or government by the few, which would only become universal suffrage after many years of demands, although participation would be limited to the election of representatives. What was won by relegating participation was the preservation of property and civil liberty, resulting in many states in a bill of rights.

It can be stated that liberal democracy was conscious of its "betrayal" of the principle of political equality and that this led to the subsequent expansion of suffrage during the nineteenth century and the beginning of the twentieth century, until universal suffrage was reached. Recently, the lack of real political equality and the recognition of obvious shortcomings in government by the few, revealed since Rousseau and the elitists, has led governments to open up to greater citizen participation, although in a selective manner. As Michels pointed out, it is no longer possible to believe that going to the polls and trusting our social and economic interests to some delegates would assure our direct participation in power (Michels, 1962).

A part of democratic liberalism has embraced the taken up of republican logic and understands that participation in public life is not only necessary to preserve and strengthen the state, peace, and liberty but also essential to being a good citizen and directing individuals' actions toward the common good. In this way, participation acquires a pedagogical sense in forming good citizens capable of contributing virtue and high aims to political life in exchange for honour and justice (Held, 2006).

We have now looked at both sides of the dilemma of modern democracies: participation understood as inseparable from citizenship and, therefore, as the civic obligation of all citizens, who will improve as persons in their collaboration in the creation of the common good; and participation in collective power as a right that improves the life of the community and corrects some of the excesses of representative government.

The first approach is connected with the postulates of direct democracy and needs citizens that are politically and economically equal so that they can make autonomous judgments. In this process, citizens do not only try to improve humanity but also to improve morally. The role of political institutions will be to favour "the general advancement of the community, including under that phrase advancement in intellect, in virtue, and in practical activity and efficiency" and "organise the moral, intellectual, and active worth already existing, so as to operate with the greatest effect on public affairs", hence, the government should be judged "by what it makes of the citizens, and what it does with them; its tendency to improve or deteriorate the people themselves, and the goodness or badness of the work it performs for them, and by means of them" (Mill, 1991). In short, in this conception, democracy is a process for achieving civic virtue in which participation is a means for personal development.

The second approach guarantees our private independence. However, we face the risk of enclosing ourselves "within the dull precincts of a narrow egotism" due to participation robbing us time (Tocqueville, 1956) and others governing for us. One of its foundations is the great difficulty of having and managing information for collective decision making, which impedes the decision-making process from being the result of a debate among all. Today, this limitation can, undoubtedly, be reduced with the introduction of *e*-participation instruments. However, the incorporation of corrective elements to the current system of political representation would require the rethinking of some of the fundamental concepts of representative democracy. If this does not happen, it is probably because participation is in decision-making areas that are not of great importance to the community.

2.6 Challenges for Democracy

Up to now, we have dealt with some of the principal issues that emerge in understanding democracy. The construction of this system of government has been the result of a rich debate which has attempted to address the social, economic, political and institutional characteristics of each historical period. This permits us to state that there is no ideal type of democracy, nor is it possible to "prescribe" a normative model, as is often done by international bodies for states that do not belong to the club of democratic countries. When this is done, this results in the appearance of states with formal, but not real, democracy. In this sense, Dahl (1998) points out that the essential conditions for democracy to thrive are control over military power and the police by elected officials, the existence of democratic values and a democratic political culture, and the inexistence of a foreign control hostile to democracy. To this, he adds as conditions favourable to democracy the existence of a market economy and a modern society, as well as a light cultural variety. It is evident that many countries in which democratic constitutions exist do not meet all these requirements.

Democracy is a clear Western product, with its origin in the liberal state, and has been constructed by numerous thinkers, politicians, social movements and by tradition and political practice for more than 200 years. In this process, each society has opted for diverse solutions to the problems that have emerged, but this does not mean that the existing model in each country is the most evolved form from the specific historical process. This implies that there will always exist problems for democracy, just as there are for life in society, and that some of these emerge from the past just when we thought that they had been overcome, as is currently happening in the debate around *e*-democracy.

This chapter has tried to show that the central questions for democracy today are not so different from those of the Greeks or, more recently, the first liberals; nor are the problems or challenges to be faced that different. The introduction of information and communication technologies in the mechanisms of democracy and its conceptualization as *e*-democracy reopens old questions about direct democracy that were discussed in previous pages. The challenge is to set out solutions, not global ones but rather solutions adapted to each situation, environment, collective, issue, etc. Two centuries of representative democracy have shown us that it is a good mechanism for resolving political conflicts of a general character, although it presents problems in specific areas. Undoubtedly, a focus on *e*-democracy can lead to a strengthening of representation if not to an alternative in some specific cases, as well as a strengthening of the citizenry which can widen its decision-making capacity and its knowledge of political activity.

The first challenge raised is that of civic education and knowledge. Both Plato and Aristotle were concerned about the knowledge necessary to deal with political affairs. For Aristotle, one of the characteristics of democracy was its rustic nature. For John Stuart Mill (1991) one of the dangers of representative democracy was the "low grade of intelligence in the representative body, and in the popular opinion which controls it". This issue raises the question today of whether the average citizen possesses the information and knowledge necessary to rationally evaluate government decisions, as Schumpeter stated (1976). The answer cannot be other than negative. This leads radical democrats to again take up the need to deepen within the civic virtue of the citizens and their knowledge of public affairs, proposing their active participation in political processes as the most effective method for doing this.

Dahl argues that if the institutions in charge of promoting civic education are weak, there is only one satisfactory solution: they must be strengthened. Along the same lines, he also insists that another essential aspect for strengthening democracy is the existence of a democratic political culture based on democracy and equality being desirable ends; that basic democratic institutions must be preserved; and that differences and disagreements between citizens must be tolerated and protected (Dahl, 1998).

The second challenge is that of effectiveness. The first liberals were conscious that "democracy does not confer the most skilful kind of government upon the people" because it does not "display a regular and methodical system of government" (Tocqueville, 1956). This second problem has been partially resolved through giving the task of the executive function of government to enormous professional bureaucratic apparatuses, though this has created doubts about their legitimacy and responsibility because of their democratic deficit. However, the question of the effectiveness of democracy still exists when we ask whether democratic institutions really consider citizen preferences in their governing preferences. Another issue which derives from this is whether these institutions are really adequate for channelling these preferences. It is likely that democracies are as they must be and that they have managed to achieve a certain effectiveness in their management of public affairs and a relative stability, but it can also be stated that we can see a worrying distance between political institutions and their leaders and the citizenry, which is eroding the legitimacy of the democratic system.

The previous issues refer to the central problem of current democracy, which is the question of representation. We can say, as Michels (1962) does, that "that which is oppresses *that which ought to be"*. In other words, the clear dominance of political parties and political-bureaucratic structures overwhelms the representation of the needs and preferences of the citizenry.

Perhaps the problem is found in the very mechanism of representation, which is designed to gather the preferences of a big number of citizens over political party lists and not to channel the preferences and needs of those citizens. The historical explanation is that liberal representative democracy was the response to the implementation of democracy in large countries and complex societies with a great diversity of interests to be addressed. However, perhaps at this moment it is necessary and timely to rethink some aspects of representation in light of new technologies and current social complexity and fragmentation.

Currently, representatives are not subject to a binding mandate or to recall and their accountability to the electorate is limited by the interference of political parties. This favours the creation of a political and technocratic elite, which, in advanced societies, shares in great part cultural values and interests which are not necessarily those of the citizenry. In this way, representative democracy has averted the danger which direct democracy represented of government by the many, although at the cost of government by the few, leading the system toward an oligarchic or aristocratic model. Thus, we can conclude, as does Schumpeter (1976), that democracy is the government of the politician and that "the will of the people is the product and not the propelling power of the political process."

In addition to the above challenges to democracy, Dahl (1998) adds the challenges of the tension between capitalism and democracy and its impact on political inequality, the democratization of international organizations, the integration of cultural diversity, and the improvement of civic education to increase the capacities of citizens, so that they can be more involved in political life and can face the complexity of public affairs.

The last issue to be dealt with is that referring to citizen participation. The current challenge is not so much increasing participation to the point that it substitutes current decision-making mechanisms through political representation in democratic societies but to avoid that the incorporation of participatory instruments in the political process reinforces the elitist tendency in the political system with the inclusion of new social leaders who produce greater distance from citizens and a loss of legitimacy in the system. The current exercise of political power can assume without great cost, from a neo-corporative or similar logic, the incorporation of new social groups, which does not mean that the interests of the majority of the citizens are better represented.

Perhaps the future of democracy lies in deepening and perfecting it, particularly through strengthening the systems of responsibility and transparency for political leaders, eliminating some of the prerogatives of the parties and providing greater political education to citizens, especially in regard to that which provides greater capacity for understanding of government action, in which the focus on *e*-democracy and information and communication technologies can undoubtedly help.

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Chapter 3
Participatory Processes and Instruments

José M. Lavín and David Ríos Insua

3.1 Introduction

Our current, mainly representative, democratic institutions stem from times when transportation and communications were difficult and time consuming. Since then, politics have evolved little and politicians have developed a style in which little feedback is accepted from citizens, except at electoral campaigns. This has entailed apathy and a feeling of alienation among citizens, leading to the so-called *democratic deficit* (Steffek et al., 2008), reflected e.g. in low participation rates in elections. Politicians might not be that worried with apathy or citizen protests, but low participation entails a loss of legitimacy. This has led to the development of greater participation and involvement of citizens within public policy decision making. Thus, institutions are promoting participatory initiatives. The broad idea is that public authorities, when faced with an important issue, should draw together a range of stakeholders in a workshop or a series of workshops (or similar events: citizen juries, town hall meetings, focus groups,. . .) to explore the issue and formulate policies. Most politicians' motivation to promote this movement towards more participation probably relates more to gaining greater public acceptance of the ultimate decision than to promoting democratic ideals. However, whatever the cause, there is undoubtedly wider use of participatory methods in societal decision making in many countries.

As described in **Arenilla**, there are many variants of democracy, ranging from representative parliamentary democracies through to the Athenian ideal of direct democracy. Correspondingly, there are many variants of participation. As a first example, a participation process could be part of a direct democracy and conclude with a binding vote among all citizens on the alternative to be implemented. In a second example, the authority and responsibility for the decision now remains firmly

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within the government. However, in the process leading up to that point, they interact with citizens and stakeholders. In the former case, there is a clear imperative to ensure fair representation of all citizens in the process and the highest levels of security. In the latter case, these constraints may be softened by the agency concerned, modifying the decision if it feels that there has been systematic under-representation of groups.

In this chapter, we shall review key concepts in participatory democracy, describe some important participatory tools and processes and dissect them to identify their basic components in terms of basic group decision-making tasks, with a view towards implementing a web-based architecture to support participatory processes.

3.2 Participatory Democracy

Over the last 40 years, all over the world, citizens and political scientists have increasingly demanded greater participation in the incumbent public policy decisions, especially at a local level, this being the closest to the citizens. Reasons for this have changed over the years. Thus, in the 1960s, emphasis was placed on legitimizing public decisions. In the 1980s, emphasis moved towards including appropriate stakeholders in public policy decision-making processes. Finally, the beginning of this century witnessed a shift towards including ordinary citizens who may provide useful local knowledge, besides diversity. The organizations demanding participation have also changed over the years. The decentralization and thinning of the state which started around the 1980s (see Cable, 1995), originated an enormous growth of citizen associations, either as neighbour, special interest or professional groups. These associations felt that the State was no longer sufficient to defend their rights, therefore demanding new ways to act on, which, in turn, entailed greater citizen involvement in the *res publica*.

One of the motivations for this demand is the existence of the so called democratic deficit. Levinson (2007) considers that *a democratic deficit occurs when ostensibly democratic organizations or institutions in fact fall short of fulfilling what are believed to be the principles of democracy*. This deficit grew over the twentieth century and, especially, the first decade of the twenty-first century. Although it was clear for leftist theoreticians in the 1960s that the liberal democratic system lacked participation, in the 1970s this became a real issue for citizens. As an example, in 1977, in reference to the, by then, European Economic Community, an organization called Jeunes Européens Fédéralistes launched a manifesto in which the term democratic deficit appeared for the first time. The case of the European Union is somehow paradigmatic: this supranational organization coordinates the policies of its 27 member countries and from its very beginning had a Parliament. However, its activities were, for several decades, somewhat irrelevant, as decisions were largely made by the executive body, the Commission. However, from 1992 on, with the foundation of the current European Union, the interest about citizens knowing and participating grew considerably. In order to mitigate such *democratic deficit*, the EU has strengthened increasingly the European parliament and tried to stimulate various participation forums.

We have already commented that demands for citizen participation have grown since the 1960s, and the term has been used profusely. The key idea is that voting, say, every four years, is insufficient and that politicians, especially in systems with blocked and closed lists with proportional representation, somehow forget their voters once they have been elected. From the 1990s, this feeling has grown, especially in times of crisis or when corruption scandals have arisen. Citizens tend to feel that current political participation ways are not sufficient and want to be involved in more affairs, especially those closer to its local sphere. This would entail a number of advantages, including the following:

- Active citizen participation increases the legitimacy of the decisions made. Incorporating several perspectives and the ensuing debate enriches decision-making processes. Moreover, such debate should increase acceptance of the decisions as well.
- In a similar vein, the transparency of decisions is increased, as they are no longer made remotely from citizens.
- There is added value in the publicity that administrations need to make to support participation processes. We can no longer talk about lack of information or distance.
- Citizens may actually participate in policy formation. We can no longer talk about remoteness: the citizen who feels alienated is one who did not want to participate.
- At the local level, the knowledge that citizens have about their own environment may be especially relevant, which should be taken into account when making decisions.
- Both governors and governees gain insight through participation processes. The first are reminded that they have been chosen to represent governees. The second understand that policies entail costs that may make some decisions unpopular.

In our discussion, the debate between direct democracy and representative democracy, see **Arenilla**, will be very important. On the one hand, we have the need and right of all citizens to take part in relevant decisions, traditionally through debate and voting. On the other hand, for logistic reasons it is very difficult, if not impossible, that all citizens take part in decision making. Stuart Mill (1861) dealt with such issues when he remarked that, in spite of the considerable development of Athenian democracy, its success would be limited to the local sphere, as there were no conditions to properly establish and propagate public opinions, until the emergence of the print and newspapers to act as substitutes of the Forum.

Thus the representative system emerged because of the near impossibility of citizens attending assemblies leading to the election of representatives and, subsequently, to the creation of political parties. Political representation reflects how political power and national sovereignty are given away by citizens to a small number of members for a period of time. Since the États Généraux which originated the French Revolution (1789) or the first US Government (1776) and, especially, with the liberal revolutions of 1830 and 1848, citizens have become electors, clustered around a party or an association. This is the prevailing model and has permeated most organizations, from neighbour associations to trade unions. Pitkin (1967) defines *democratic representation* as a relationship in which representatives make decisions and are chosen through elections, with a mandate limited in time, share certain characteristics such as ideology or interests and have a certain emotional identification with the person who chooses them to act on their behalf, therefore being accountable.

Stemming from the concept of Representative Democracy, several other concepts and forms emerge to improve and reduce its deficits, including Participatory Democracy and Deliberative Democracy. We quote them through their Wikipedia definitions as of December 2009:

- participatory democracy strives to create opportunities for all members of a political group to make meaningful contributions to decision making and seeks to broaden the range of people who have access to such opportunities.
- deliberative democracy, a term introduced in Bessette (1980), sometimes also called discursive democracy, is any system of political decisions based on some tradeoff between direct democracy and representative democracy that relies on citizen deliberation to make sound policy. In contrast to the traditional theory of democracy, which emphasizes voting as the central democratic institution of democracy, deliberative democracy theorists argue that legitimate lawmaking can only arise from the public deliberation by the people.

See **Lourenco and Costa** for further details. Note that both concepts have many points in common as they emphasize decision making through participation in the first case and deliberation in the second. Thus, they complement each other.

Clearly, free deliberation requires formal conditions such as equal freedom to take part among participants, openness to all topics, internal and external transparency and ample communication opportunities. In fact, five features tend to characterize deliberative democracy as described in Cohen (1989):

- An ongoing independent group with expected continuation.
- Citizens structure their institutions so that deliberation is the deciding factor in their creation.
- A commitment to the respect of a pluralism of values and aims.
- The participants regard the deliberative process as the source of legitimacy.
- All members recognize and respect each others' right to deliberate.

Indeed, we can speak of a range of democratic models that go from direct democracy to a purely representative model deliberative democracy, a term introduced in Bessette (1980) sometimes also called discursive democracy, is any system of political decisions based on some trade-off between direct democracy and representative democracy that relies on citizen deliberation to make sound policy. As an example in 2004, only 21% of Polish citizens voted in the European elections, whereas in Slovenia only 17% of voters exercised that right. One might think that this phenomenon affects only the countries that have recently joined the European Union, but it is widespread all over Europe. The rates of voter participation in the Union average around 45.5%, though this includes Belgium and Luxembourg where voting is compulsory.

It is also interesting to discuss an issue which is not very frequently examined but which is of importance in analysing citizen participation – that of displacement of responsibility. It is widely said that the election of representatives and the end of mandatory instructions from the electorate responded, in theory, to the need for calmer, more complete and long-term reflection over necessary and effective policies, even if unpopular in the short and medium term. Decision making on the part of poorly informed citizens or with little concern for the future could have serious, even disastrous, consequences. In addition, central power could be weakened if citizen decisions delegitimize their actions.

Currently citizen participation is mainly having effect at the local level. This means that the local level may acquire unexpected power and legitimacy relative to the central level. As a result, central governments may need to increase the possibilities for citizen participation. Indeed, so far, most of their efforts seem to have focused on providing online administration services but, practically, without offering channels for citizens to give their opinions, make petitions or make decisions. Therefore, central governments should consider creating additional paths for interaction with citizens. These considerations should be taken into account before proposing radical solutions for greater citizen participation.

3.3 Participatory Instruments

One of the consequences of the success of citizen participation across the world has been the creation of many participation instruments. In fact, it is estimated that there are more than one hundred participatory instruments (Rowe and Frewer, 2005). In addition, their number is growing as hybrids of mechanisms are being created for different uses. This very success leads to three problems: First, of a practical nature, an instrument that has been successfully used in one place can fail when it is used elsewhere, not sharing the same characteristics. Secondly, a theoretical problem emerges as there are difficulties in establishing classifications of these instruments due to their number and nature. The third problem results from this theoretical problem: terminology in this field has yet to become standard. Indeed, some might say it is somewhat confusing with different terms being used by different authors for similar entities and, conversely, the same term being used for different entities by different authors. As an example, the instrument called citizen's juries, described below, has sometimes been used synonymously with terms such as consensus conferences, or deliberative focus groups.

We shall distinguish between a *participatory process* and *participatory instruments* (or *techniques*). A participatory process is the entire series of interactions between authorities, stakeholders and citizens from the initial exploration of issues of concern up to the conclusion of the deliberations and resolution of the matter. During the process, several participatory instruments (e.g. stakeholder workshops, opinion polls or open meetings) may be deployed to enable the participants to interact.

It is not our intention to provide here a classification of participatory instruments. However, by describing some of the classifications proposed we can illustrate different principles underlying those instruments. Sintomer (2008) supports the development of six "ideal" Weberian classification models based on different participation concepts:

- *Representative Democracy + Direct Democracy*: In this first model, elements of direct democracy are joined with traditional representative democracy in the governing process. It is a highly politicized model. It uses referendums, assemblies, etc. to complement the decisions of those who govern.
- *Proximity Democracy*: This second model is the most widespread and centres on the modernization of the state at the micro-local level. Here an intense communication exists between institutions and citizens, mainly through neighbourhood councils, political parties, consultative assemblies and citizen councils.
- *Participatory Modernization*: This model is centred on the modernization of the state through citizen participation. Politicization is almost non-existent as it focuses on administrative mechanisms, particularly through online services.
- *Public/Private Partnership*: This model is centred on the work of a group of public institutions and private businesses, coordinated through meetings and round tables where both sectors work together to achieve common objectives of an economic nature. The citizen is barely present.
- *Community Development*: This model is based on participation through co-decisions, co-management and, even, self-management. Its objectives are of a social nature and are centred on social "empowerment".
- *Neocorporative*: This model is based on coordination through meetings of different social collectives such as NGOs, unions, businesses and churches with local governments. Its objectives are of a social nature. The intention is to organize these groups around social objectives, unifying the actions of these distinct collectives as well as possible.

Rowe and Frewer (2005) centre their classification on two aspects: the transparency of mechanisms and their efficiency. The concept of transparency is, among other things, associated with representativeness, equality and democracy. The concept of efficiency is related to the idea of transmitting the most important information to the greatest possible number of citizens. The concept of *public engagement* is linked with these two concepts. From their union, three types of mechanisms for citizen participation emerge based on who provides information and who receives it:

- Public communication: the information comes from sponsors to the public, the sponsor being whoever initiates the relationship, either a governmental agency or another institution.
- Public consultation: the information comes from the public and is directed at sponsors, following a process initiated by the latter. There is no formal dialogue between individuals and the sponsors.
- Public participation: there is an exchange of information between members of the public and sponsors. There is, then, a dialogue in the process although it does not have to be of equal degree from both sides.

In French et al. (2005), we find a survey of criteria which may be used to classify participatory instruments. These include the following:

- Participants: both in terms of how they are selected to take part (open, closed, expert sampling) and their number.
- Timescale: referring to the timing, duration and frequency of the process, and interaction duration.
- Type of engagement: whether it is for information or decision-making purposes.
- Direction of the information flow: This could be from the public to the sponsor; from the sponsor to the public; or bidirectional, as in Rowe and Frewer (2005).
- Structure: Three types of options for the organization of these mechanisms are identified. The first is whether participation is structured according to a particular model or whether it is free-flowing. The second is whether the participation is open to all or limited to experts, citizens, etc. The third option refers to whether there is an analytic or model structure.
- Type of interactions: This aspect refers to the distinct types of encounters or relationships that can take place among participants.
- "Owner" of the process: Some mechanisms could need external authority for leading the process. This authority controls the activities of the process, and it is called "owner"
- Scope: whether it is local, regional or national.
- Financing, which could be public, private or mixed.

We shall not provide here an exhaustive list of instruments. For this, see Rowe and Frewer (2005), Iglesias et al. (2004) or French et al. (2005). But we should note that among the mechanisms for participation, some are much more popular and established than others. This could be due to various reasons such as the simplicity in setting up the mechanisms, their adaptability or the degree of consensus that they can foster. Some important examples are as follows:

1. *Citizens' Juries* (www.jefferson-center.org): The term was created at the end of the 1980s at the Jefferson Centre in Minneapolis. Inspired by courtroom juries, they decided to give this name to the so-called *citizens' committees* that had been in existence since the mid-1970s. In addition, they decided to copyright the name to protect the process and create a very complete handbook. In reality, this type

of mechanism had existed in Germany since the beginning of the 1970s, though it has been since the 1990s that it has reached its greatest fame, spreading across the world while undergoing some changes and mutations in its use. Citizens' juries are groups of citizens, chosen at random from the population, who meet over several days. The facilitator or facilitators propose an issue or a question about an issue. They provide information about the issue to the jury through *witness testimony* from experts. The jury then deliberates and issues findings and recommendations, which are only consultative. The juries deal with local or even state-wide issues, or often moral issues, such as the use of stem cells in research, are publically financed and their activities should have impact across a range of media (newspapers, Internet, television, etc.).

2. *Interest Group Workshops* (de Sousa Santos, 2004) are meetings of participants that are chosen from among the population. Previous information gathering by the participants is necessary. The workshops are intensive, lasting several days, and the flow is from the authorities to the public. The agreements are binding. They are also different from Citizens' Juries in that the facilitators are independent mediators who run the meetings in which decisions are made. The facilitators aid the discussion and catalyse the sharing of information. The scope is often local or regional, and financing tends to be mixed. In recent years, and with the introduction of new decision-making technologies, a technical analyst is often a member of the facilitation team.
3. *Referendums* (Budge, 1996) are one of the oldest and most well-known political instruments. A direct question from the government to the people has always been in use, whether under dictatorships, monarchies or democracies. Born under the Roman Republic, it was in 465 B.C. when the dictator Quinto Hortensio introduced the obligation to respect the opinion of the plebiscite. It is an instrument par excellence of semi-direct democracy, being a procedure for decision making in which voters exercise their right to vote to decide on a specific proposal. It is aimed at the whole population by asking them a question. This question is discussed in the media. The answer can be consultative or binding. The referendum is a political tool that must be used carefully. First, because a certain participatory fatigue may occur and, second, because a referendum can be used by the executive power to get around the legislature. Symptomatic of this danger was the use of the referendum in France during the Sixth Republic in which President de Gaulle, avoided the defeat of some of his most controversial projects in the parliament by directly appealing to the people through referendums.
4. *Decision conferencing* (Phillips, 1984) This instrument is based on meetings in which a specific theme or issue, proposed by the leading stakeholder of the problem (the government, the chief executive officer, etc.) is discussed. The conference takes place over 2 or 3 days, and the main idea is to include and communicate with all stakeholders in such a way that it leads to imposed decision making with the aid of a decision analyst. See Gregory et al. (2005) for some public policy applications. See also **Efremov and Ríos Insua**.

5. *Consensus Conferences* (www.tekno.dk). They are based on meetings between a group of citizens, balanced by age, educational level and sex, and experts on matters relevant to the proposed issue. The discussion is facilitated by an independent mediator. Generally, the group receives a briefing and information on the issue before the conference begins. The conference usually lasts 3 days. On the first day the experts present their opinions on the issue from social, ethical, economic or other perspectives. The second day, the citizens ask the experts questions regarding the issue and their opinions. In addition, they begin drafting a final report. The third day the draft report is discussed and the final document prepared. These conferences are open to the public, to experts and the media, and the results are published. Occasionally these reports play a direct role in legislation. See Andersen and Jaeger (1997) for examples.
6. *District forums* (de Sousa Santos, 2004), also called Town Hall meetings, are meetings convened by local authorities, in a neighbourhood, open to the public and in which all neighbours are invited to participate. Prior to the meeting research on the issues and problems affecting the neighbourhood and what local policies could be implemented is undertaken through the use of questionnaires. The forums are consultative, and the intention is to create a permanent and ongoing dialogue between citizens, neighbourhood associations and local authorities. This is one of the most successful mechanisms, particularly in Latin America and, most specifically, in Brazil, the origin of many of these tools.
7. *Citizens' panels* (Brown, 2006): These are panels of citizens which deliberate over various public issues. They are generally formed through the initiative of local authorities. They were created in the 1980s, and their most significant use has been since the year 2000, when more than thirty British municipalities began to use them. The panels are instruments for consulting the community, in which a group of non-specialized citizens, from 500 to 2,000, are asked to evaluate a problem or proposal through public discussion or online forums. This aspect is important, as it permits the use of new technologies. Called periodically, their ultimate aim is to produce and discuss relevant texts so as to produce a final report. However, their flexibility means that on occasion they can be quite volatile. For this reason, it is recommended that the issues they deal with be very concrete and not overly specialized, because the citizens are chosen at random.

Applications of participatory instruments have been varied. Indeed, the popularity of some of them has meant that they have been implemented in very different situations, including some in which the use of the mechanism was not advisable. As examples of the use of these mechanisms we find the following:

- Through the Jefferson Centre, citizens' juries have been used to discuss issues such as tax reforms, electoral reforms, waste recycling or the right to assisted suicide.
- Interest group workshops have been successfully used for environmental issues and urban planning. An example of that use could be the work of different groups with the government of the city of San Diego.

- Referendums are widely used throughout the world. Perhaps the broadest with the greatest number of participants was that on the proposal by the European Union for the approval of the "Treaty establishing a Constitution for Europe," which was voted, independently, by five countries in 2005 (Spain, France, Holland, Luxembourg and Ireland).
- Decision conferencing is used by many and for various issues such as the resolution of conflicts, the evaluation of efficiency and effectiveness of public policies and the management of crises (Gregory et al., 2005).
- Consensus conferences have also been used for multiple issues such as telecommuting, risks associated with genetically modified foods, etc. For additional issues see: http://www.pantaneto.co.uk/issue6/andersenjaeger.htm.
- Neighbourhood or district forums have been used to discuss very local issues in neighbourhoods, such as the paving of roads, lighting, health or other issues of a similar, and limited, nature.
- Citizens' panels also tend to be local level instruments, but with a broader perspective than neighbourhood or district forums. Panels generally deal with issues such as the environment, transportation or other municipal policies. For more examples, see Crosby et al. (1986).

3.4 Participatory Tasks

Despite the enormous variety of instruments, if we analyse them in detail, we find that they are essentially a combination of some of the following basic participatory tasks:

1. *Participant sampling*. In many of the mechanisms, participation of all citizens is impossible for logistical or physical reasons. Thus, a group (sample) of citizens is chosen to represent the wider population. This sample could be purposive, random, etc. depending on the proposed issue, theme or problem.
2. *Election of representatives*. For similar reasons, representatives are sometimes elected. They are the interlocutors in the debate and responsible for expressing the opinions of the collective of participants. They provide directions to the participant groups to avoid waste of time and make the process more efficient.
3. *Use of questionnaires*. These aid the determination of the main issues of interest, revealing what matter most to citizens.
4. *Preparation of prior documents*. These are documents preliminary to the process. They contain the information about the issue or problem and, perhaps, the structure of the participation process. They are usually written by experts
5. *Distribution of information*. An important element in decision making is having as much information as possible on an issue, whether theoretical, practical or regarding past experiences, etc. This information should be available to all participants to facilitate decision making.
6. *Sharing of information*. Similarly, participants should be able to share the information that they, themselves, possess.

7. *Problem structuring*. Sometimes problems might not be clearly formulated and participants need to spend time structuring the problem, dividing them into parts so as to better apprehend it; see **Carreras and Franco**.
8. *Alternative generation* ("optioneering"). Participants usually spend some time proposing alternative solutions to the problem at hand, possibly aided by brainstorming techniques.
9. *Preference modelling*. Participants are sometimes required to express their preferences over consequences or alternatives, possibly through pairwise comparisons, goal setting or value functions, see **Efremov and Ríos Insua**. Voting might be included here, but we treat that separately.
10. *Belief modelling*. Participants may need to forecast possible scenarios in relation with the issue at hand.
11. *Individual problem exploration*. Participants are sometimes allowed some time to explore the problem individually, to find their most preferred alternative; see **French**.
12. *Debate*. Whether regulated or spontaneous, the interchange of ideas may be vital for citizen participation: a group of citizens or experts, or both, discusses about an issue, perhaps with the aid of a facilitator.
13. *Negotiation*. When individuals disagree on their preferred alternative, they may try to deal with the conflict through negotiations in which participants exchange offers, ideas and arguments so as to try to reach a consensus; see **Efremov and Ríos Insua.**
14. *Arbitration*. Through debate and negotiation, we may find that the parties involved cannot be satisfied and refuse to budge from their positions. To avoid this. Some mechanisms include the figure of an arbitrator who makes the final decision once the opinions and reasoning of the different parties have been presented; see **Efremov and Ríos Insua**.
15. *Voting*. Many times voting is the last step of the decision-making process, particularly if consensus is deemed unreachable. It can be done following different rules, such as simple majority, approval voting, Borda count, ... See **Nurmi**.
16. *Preparation of posterior documents*. These are documents resulting from the participatory process, containing the results, a summary of the debates and the decisions adopted. They are usually written by representatives and/or experts, but see **Lourenco and Costa**.
17. *Explanation* (*to citizens*). The resulting documents should be available to the citizenry. It may also be necessary to provide an explanation of the decisions made directly, in other words, through institutions or through representatives in open presentations.

To conclude this section, we will describe the sequence of participatory tasks typically associated with the participatory instruments we have described above:

Citizens' juries: Participant sampling; (sometimes) election of representatives; distribution of information; debate; voting; final reporting.

Interest group workshops: Preparation of prior documents; choosing of representatives; debating; final reporting.

Referendum: Preparation of prior documents; Distribution and sharing of information (through campaign); debating (through campaign); voting.

Decision conferencing: Participant sampling (purposive); Distribution of information; problem structuring; preference modelling; alternative generation; debating; negotiating; final reporting.

Consensus conferences: prior reports; distribution of information; debating; final reporting.

District forums: Participant sampling; distribution of questionnaires; debating; voting; final reporting.

Citizens' panels: Participant sampling; prior reports; debate; voting; final reporting.

3.5 Discussion

Since the 1960s, there has been a growing consensus on the benefits of promoting participation, most importantly the reduction of the democratic deficit. As a consequence, participatory instruments are flourishing across the world, including those briefly described above. Many of them are quite similar. Some are only meant to inform politicians; others allow for co-participation among citizens and politicians; yet others actually allow citizens to make decisions. It is important to stress that many of them have been initiated and tested at the local level, a context in which it is recognized that citizens may provide very useful local knowledge that would, otherwise, remain hidden.

We have seen that there exist a great number of mechanisms and participatory activities developed in different parts of the world. The demand for participation, therefore, has channels through which to develop. Another, but very different, issue is whether this development is seen favourably by certain sectors of the political class. Traditional politics is frequently fearful of new ways of expressing opinions and making decisions. We believe, though, that the new participation instruments would not supersede or substitute representative democracy. Rather, it is an attempt to mitigate the defects of such systems, see **Arenilla**.

It is important to look at several relevant issues. First, note, that, often, the initiative for participation is institutional and not spontaneous. Although we have mentioned the demand for greater participation on the part of the citizenry, it is clear that in recent years public institutions are taking the initiative in proposing issues to the public. Thus, it is the municipalities that are creating new forms of participation such as meetings or participatory budgeting, see **Alfaro et al**.

It should be noted also that an excess of participation can end up being counterproductive. The population may stop participating in consultations and assemblies, when they occur too frequently. In addition, this can lead to situations in which governments or parliaments, fearful that popular participation will weaken their initiatives, look for consensus solutions, attractive to the population but without the forcefulness that is needed.

Attention must be paid also to the incorrect use of tools and procedures for participation, which can lead to errors if they are not used in the appropriate context. Certain tools could become popular and used as a panacea for all types of problems. For example, the use of referendums in which voters can choose "yes" or "no" could be inappropriate when facing complex decisions.

An additional issue is that the democratic intention of participatory procedures could be subverted by powerful pressure groups, which with their economic strength and influence on the media can take advantage of openings in the legislative and executive process.

Finally, we should mention that this wave of participation may need to be accompanied by the introduction of new technologies, not only to update old processes and mechanisms but also because these technologies could, in some way, transform democracy itself. As an example, physical meetings of citizens and politicians will not be as relevant as the Internet makes it possible to conduct citizen and stakeholder interactions in a distributed, possibly asynchronous fashion. The world of the twenty-first century will be electronic and mobile. It is not surprising, therefore, that digital trends are affecting the political facets of life and that concepts of *e*-government, *e*-democracy and *e*-participation are being debated and implemented in various ways. Indeed, we could view the Internet as an opportunity to bridge the gap between governors and the governed. In a sense, our institutions are out-of-date, unable to take advantage of novel technologies. To be honest, so far most relevant *e*-participation tools refer only to *e*-debating and *e*-voting. We ought to ask ourselves whether ICTs should not serve to deepen our democratic procedures and transform them and not only to provide traditional procedures with an additional support.

The challenge, then, is clear: how can we employ ICTs to support and strengthen democracy and, thus, avoid current problems such as the democratic deficit? In our opinion the strategy is clear and simple and begins with what was previously described, as we summarize here:

- Numerous instruments of participation have been introduced and are being introduced in the physical world.
- A detailed analysis of these shows that they all include a limited number of tasks in a specific format.
- In our opinion, most of those tasks may be done in the most effective manner with the aid of ICTs.
- It is therefore possible to devise a meta-strategy from which to choose among the different participatory instruments.
- We should then implement with ICTs such a meta-strategy.

John Stuart Mill thought that despite the great development of the Athenian democracy, its success was due to its small scale as the material conditions did not exist to establish and propagate public opinion, until the appearance of printing and the newspaper, which would substitute for the Athenian forum (Mill, 1861). One hundred and fifty years later, perhaps with the aid of ICTs we could actually find a universal forum for participation.

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Part II
Methodological Bases

Chapter 4
Problem-Structuring Methods for *e*-Democracy

Ashley Carreras and L. Alberto Franco

4.1 Introduction

The significance of problem definition in policy making is widely acknowledged (e.g. Landry, 1995; Lyles and Mitroff, 1980; Nutt, 1992; Rosenhead and Mingers, 2001; Smith, 1994; Thomas and Samson, 1986). At the individual or personal level, social actors are constantly striving to make sense of their internal and external environments in order to manage and control their lives. This sense-making process is facilitated with the help of a unique mental framework that is developed through experience and interaction with others and which includes systems of beliefs and values (Berger and Luckmann, 1966; Schutz, 1967; Weick, 1995). A 'problem' emerges when the use of such a mental framework, to make sense of a particular social situation, leaves the individual uneasy or dissatisfied, because she/he does not know how to deal with that situation. Because different social actors will experience different problems by applying their own unique mental models to what might be thought of as the same situation, problems will always have an owner or owners ascribed to them.

Thus we might expect that early attempts at formulating and structuring the issues that constitute the problem to be deliberated in a democratic system are likely to encounter multiple versions of the same issues. These other versions of reality will become apparent as the different articulations of the issues are collated during the early stages of deliberation. From the point of view of using decision-analytic models to support democratic deliberations, one key challenge becomes not so much to model what will become the actual problem to be addressed but to identify and model the different perceptions of the issues comprising the problem held by social actors. We should make clear that the need to understand a particular problem and the issues arising within it may be an end itself, at least in the short term, rather than a choice or optimization problem in the OR/Decision Science sense.

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It is a little surprising, therefore, that much of the literature on *e*-democracy has devoted relatively minor attention to the processes of articulating and defining problems. Indeed, French et al. (2007) have noted that the majority of work in the field has concentrated mainly on the use of technologies to automate democratic instruments such as *e*-voting and *e*-deliberation systems (Browning, 2002; Davies and Noveck, 2007). Proponents of web-based decision and negotiation analysis to structure and articulate participative deliberations have begun to make progress, and our discussion below attempts to make a further contribution towards this trend by focusing on the structuring of 'ill-structured', 'wicked' or 'messy' (Ackoff, 1974; Rittel and Webber, 1973) issues requiring citizen participation and democratic deliberation. In such situations, attempts to impose a structure on the issues too early can lead to focusing on the wrong issues and thus incurring in what has been labelled the 'Type III' error (Mitroff and Ernshoff, 1974).

In this chapter, we will discuss the role of problem-structuring methods (PSMs) (Franco et al., 2006; Rosenhead and Mingers, 2001) to support *e*-democracy. Specifically, the potential distinctive role of PSMs in assisting actors who engage in *e*-democratic deliberations to address a problematic situation of common interest will be examined. PSMs have widely demonstrated their ability to be useful with social actors working within and between organizations (see, for example, Mingers and Rosenhead, 2004). By contrast the accounts of their use with actors engaged in *e*-democratic deliberations are still limited. This chapter thus focuses on identifying what, if anything, is the distinctive potential role for PSMs in an *e*-democratic process.

The chapter is structured as follows. We start by introducing the family of PSMs developed within the 'soft' operational research tradition and reviewing briefly their main characteristics. Next, we explore the challenges that have to be addressed and overcome if facilitated structuring tools such as PSMs are to be implemented to support *e*-democratic deliberations. The chapter ends with concluding remarks and some directions for further research in the field.

4.2 Problem-Structuring Methods

During the 1970s and 1980s, the discipline of operational research (OR) came under severe criticism, partly because of its unsatisfied ambitions to address problems of strategic importance and partly because of its perceived inability to tackle complex social issues (Ackoff, 1979; Dando and Bennett, 1981). Furthermore, traditional 'hard' OR, whose methods consisted largely of algorithmic and optimizing techniques, was perceived to offer limited capability for dealing with problem situations characterized by 'swamp' conditions (Rosenhead, 1992). That is, conditions characterized by the presence of a plurality of semi-autonomous actors with multiple perspectives and partially conflicting interests; significant intangibles and high levels of uncertainty about options, and the actions of others and their likely consequences.

This period of perceived ‘crisis’ in OR gave rise directly to propositions for an alternative way of providing model-based decision support (e.g. Eden et al., 1983). As a result, a range of novel methods which collectively became known as ‘soft OR’, or alternatively as ‘problem-structuring methods’ (PSMs), were developed (Rosenhead, 1996). PSMs took from its ‘hard’ OR origins the model-based approach to enable actors to tackle issues of concern that exhibit high levels of uncertainty and conflict (Rosenhead-Mingers, 2001).

PSMs are a family of facilitated modelling approaches (Franco and Montibeller, 2010) which are intended for use with a group of actors. The key words in PSMs are ‘facilitation’ and ‘structuring’. Within the PSM field, facilitation is used to help a group of actors resolve the issues of concern through constructive conversations, aided by problem-structuring modelling (Franco, 2006). A second use of facilitation in PSMs is to deal with dysfunctional dynamics that may arise when working with groups (Shaw, 1981).

Structuring is used in the sense of identifying concepts and/or activities which are relevant to the problem situation of interest, of clarifying the relationships between them; and of focusing on key areas and excluding others, at least temporarily. The structuring process is participatory, in the sense that actors are able to construct the situation jointly, make sense of it and arrive at a shared problem definition. This participatory process is typically supported by the analyst acting both as a modeller and a facilitator (Eden, 1990; Franco and Montibeller, 2010).

Rosenhead and Mingers (2001) recognize five major PSMs: Strategic Development Option and Analysis (SODA) (Eden and Ackermann, 1998), Soft Systems Methodology (SSM) (Checkland and Scholes, 1990), Strategic Choice Approach (Friend and Hickling, 2005), Robustness Analysis (Namen et al., 2009; Wong and Rosenhead, 2000) and Drama Theory (Bryant, 2002, 2007). The major PSMs are listed in Table 4.1 with their corresponding focus, modelling approach and general purpose. More detailed presentations of these methods can be found in Rosenhead and Mingers (2001). However, it should be noted that there are a wide range of more minor brainstorming and catalytic techniques (e.g. PESTEL, 7Ss, and SWOT) that can be deployed in the process of exploring the issues (French et al., 2009).

All PSMs have been developed to capture multiple aspects of a complex problem, including objective and subjective ones. This is important because actors define a problem situation or an issue of concern in their own language and based on their own interpretations of the situation or issue, their own experience or expertise, their own value systems and so forth. A problem situation defined in this way will thus include factors that may not be typically regarded as legitimate topics in a standard decision-analytic model but that are nevertheless important if the analyst wishes to understand the needs and concerns of any particular actor. The challenge for the analyst is, thus, being able formally to structure aspects of the problem in terms of the concepts used by social actors. For if there is a doubt in actors’ minds about whether the correct concepts have been taken into account, they are unlikely to believe in the solutions to the problems produced by any type of decision-analytic assistance.

Table 4.1 Major problem-structuring methods – based on Rosenhead and Mingers (2001)

Name	Focus	Purpose	Modelling
Strategic Options Development and Analysis (SODA)	Representation of individuals' perceptions of a situation in their own language	Develop shared understanding of the problem situation leading to commitment to consequential actions	Psychological constructs and their interrelations captured through cognitive/cause mapping and analysed with special purpose software
Soft Systems Methodology (SSM)	Exploration of different worldviews relevant to a situation and contrast their implications in a process of debate	Learn about and improve a problematic situation by gaining agreement on feasible and desirable changes	Models of 'ideal' human activity systems developed through the use of rich pictures, root definitions and systems models
Strategic Choice Approach (SCA)	Recognition of key uncertainties influencing a set of interconnected choices and the management of commitments	Make incremental progress by committing to a set of priority decisions, explorations and contingency plans	Decision graphs and option graphs are used to develop a feasible set of interconnected options, which are then evaluated against a set of comparison areas which bring key uncertainties to the surface
Robustness analysis	Exploration of the compatibility of alternative, initial commitments with possible future configurations of a system being planned for	Secure flexibility of initial commitments in terms of acceptable options left open	Models are used to determine which possible system configurations perform acceptably in particular futures. Matrices capture the relative accessibility of acceptable configurations from alternative initial decisions
Drama theory	Representation of a conflictive situation involving different players and their interacting decisions	Clarify the competitive structure of a situation and identify possibilities for cooperation and scenarios which will be stable	A set of players, their options and possible strategies are captured by developing a 'card table' and exploring the stability of solutions by analysing the different potential dilemmas faced by the players

As an example, Fig. 4.1 illustrates an attempt to capture an actor's understanding of a problem using his/her own concepts. The figure shows the beginning of a 'cognitive map' (Bryson et al., 2004; Eden, 1988) used to articulate the problem of providing support to teenage parents. Nodes in the map contain statements describing the different aspects of the problem, and links between nodes denote means–end

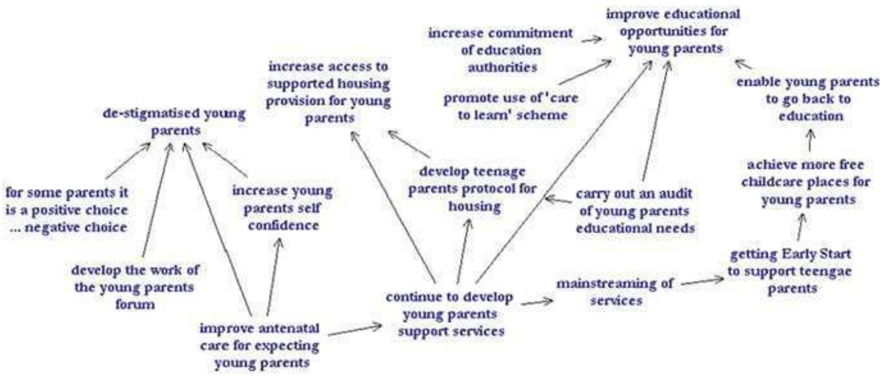

Fig. 4.1 Beginning of a cognitive map elaborating the issue of 'Support to Young Parents'

chains of arguments, for example an 'increase in commitment of education authorities' is seen by the group as a way of 'improving educational opportunities for young parents'.

Democratic deliberations involve substantial negotiation among actors having multiple interpretations of the problem of interest. This has practical implications for the use of PSMs to support democratic deliberations. As working with actors who have different views or interpretations of the problem will lead to questions concerning which interpretation(s) should be given attention. The choice does not necessarily imply favouring one particular interpretation over another but is about focusing on some combination which will often be a reflection of the our understanding of the power and influence held by key stakeholders.

A stakeholder can be thought of as any actor, group or organization that can affect or believe themselves to be affected by the problem of interest or its resolution. Identifying the key stakeholders and scoping their required level of participation represents a critical stage in the use of PSMs to support democratic deliberations. Attention to stakeholders is important because we need to satisfy those involved in, or affected by the problem, which in turn requires that the deliberations have followed rational, fair and legitimate procedures (Bryson, 2004). This does not imply that all possible stakeholders should be satisfied by or involved in the deliberations – only that the key stakeholders must be.

There are several tools for stakeholder analysis available in the literature (see, for example, the tools described in Bryson (2004)). Whichever tools are used, the actual process of choosing which stakeholders to involve in the deliberations is often the result of several iterations along the following generic stages: (1) a preliminary stakeholder analysis is undertaken using any of the stakeholder identification techniques available. After reviewing the results of this analysis, a larger group of stakeholders can be assembled if judged appropriate; (2) the assembled group should identify the list of stakeholders who might also need to be involved. The positive and negative consequences of involving – or not – other stakeholders or their representatives and in what ways to do so – should be carefully thought through; and, finally, (3) the various groups that will have some role to play in the deliberations should be finalized.

The process of identifying key stakeholders should be designed by the analyst using PSMs to gain needed information, build political acceptance and address some important questions about legitimacy, representation and credibility (Bryson, 2004). Once the required stakeholder participation is scoped, and the problem has been jointly structured and defined among stakeholders, the analyst should be in a good position to identify a particular decisional element of the problem upon which a decision-analytic model can subsequently be built.

The proposal implicit in our foregoing discussion is that the use of PSMs can aid in drawing together multiple stakeholder opinions and progressing them towards some kind of agreement on how to tackle a problem situation of common concern. When considering the use of a virtual environment for the pursuit of a deliberative democratic process, and the relevance of PSMs therein, one needs to consider the ways in which the features and characteristics of PSM processes are changed by using them in this virtual environment. These are discussed next.

4.3 *e*-Problem Structuring

For PSMs to be successful in a virtual environment it will be necessary that some of the key features that contribute to effective PSM-driven multi-stakeholder processes in the non-virtual environment are replicated in the virtual environment. If this is not possible, then efforts to ameliorate the negative impact which may be caused by the absence of these features should be made. In the following section, we summarize some of the key issues faced by facilitators of multi-stakeholder processes when working within a virtual, dispersed participant, environment. The section will end with a putative outline of what elements a virtual system designed to enable deliberative democracy might consist of.

4.3.1 The Asynchronous and Automation Challenges

One of the key differences between stakeholder meetings in the real and virtual environment is that in the latter (for the kind of processes we are considering here) the interactions are likely to be asynchronous. Whilst video conferencing and internet-based discussion forums can take place on an almost live basis, in reality such approaches to implementing PSMs would not work without a large team of well-briefed facilitators to enable the process at various locations (in terms of video conferencing). If we were to run a simple web-based forum then a whole series of other considerations need to be taken on board.

One way of understanding the pressures that the virtual environment places upon the PSM process is to think about the issues that affect a standard facilitation process in a multi-stakeholder setting, how these are addressed in such meetings and how these issues can be dealt with, if at all, in the new environment. The facilitation issues that Hemmati (2002) identified in relation to supporting multi-stakeholder process will be used here to illustrate the difficulties of placing such activities in a virtual environment, in terms, firstly, of their asynchronous nature and, secondly, of whether or not attempts to automate such processes are feasible. Of Hemmati's list of 18 facilitation issues, we will only focus on those that in our view specifically relate to the desired characteristics of a deliberative democratic process. These are: reciprocity, publicity, non-tyranny and political equality (Conover and Searing, 2005). Reciprocity relates to the respect that people should expect from, and display to, one another when offering reasons or responding to one another's arguments. Publicity is the requirement that access is open and that people state the reasons for their preferences. Non-tyranny relates to a desire that discussions and agreements are not coerced, nor should powerful groups exert undue influence on the process and outcomes of deliberations. Different viewpoints should, therefore, be open to contestation. The final characteristic, political equality, implies that all citizens should potentially have equal opportunity to influence the deliberations by having access to the deliberation arenas.

With respect to reciprocity, three issues might be of direct concern. First, facilitators need to help create an atmosphere that is both open and positive, one which will encourage not only respectful listening but possibly learning and the changing of the views among participants. Thus, facilitators need to make sure that they help the group stay focused, while at the same time enabling the participants to share concerns, thoughts and feelings. Second, participants may well feel the need to be recognized and be part of a group. Finally, where conflict arises, the facilitator should encourage participants to focus on the 'positive intent' or 'grain effect' in their opponent's position. Active listening works by asking participants to restate opposing views in their own words.

Whilst the first and third might be open to monitoring and intervention by the analysis of the asynchronous texts, the second would be very difficult to establish, not only because of the lack of visual cues but also because the degree of interaction and direct response will be limited. Automation may allow you to check for harassment and bullying behaviour, but it will not enable active listening and may directly inhibit the sense of feeling part of a group.

Regarding publicity, facilitators need to keep track of everyone's contributions, drawing together aspects of common ground and summarizing, at regular intervals, what has been said. They also need to keep track of which points might be missing in the discussion and to encourage the group to discuss aspects that have not arisen. In a virtual environment, it is possible to keep track of everyone's contribution. The problem may be one of volume. Summarization requires the facilitator to discover themes and then feed them back to the group. They will also need to then check these groupings against any preset concepts that need to be addressed. Clearly the automation of this process provides a substantial challenge (Kao and Poteet, 2007).

The principle of non-tyranny requires that sensitivity to different cultural backgrounds of participants be demonstrated and the imposition of a 'way of doing things' based on their own culture avoided. The complexity of this in the virtual environment will depend upon the breadth of the population that is asked to participate in the process, but the automated processes will have to be tested against this issue.

In this context, the previous issue is also closely related to the fourth key characteristic, political equality. Facilitators have a crucial role to play in ensuring equity in discussions. If a group is to capitalize on diversity then the facilitator needs to stress the benefits of diversity. The communication and decision-making modes depend upon the facilitator encouraging and guiding the group to put them into practice. An asynchronous process needs to monitor the contributions of the various stakeholders. Then ensure that each type of stakeholder if evenly represented. In terms of automation regular prompts to engage with the process could be set up, though they may become annoying. Maybe some commitment to a minimum contribution for each stage could be agreed upon, though this may lead to some contributing when they do not actually wish to. This, in turn, will require some commitment to the process prior to the start of the process.

As stated above, we have not provided an exhaustive list of the issues that facilitators within a multi-stakeholder process need to address but simply illustrated some of the aspects of facilitation that will impact upon the desirable features of a deliberative democratic process. Hemmati's full list is provided in Table 4.2 below, and the reader is invited to consider how they would seek to address such issues using an automated asynchronous process. Rather than continuing listing all of the issues surrounding such processes, we move on to consider what a process might look like that could address some of these issues to enhance the deliberative democratic process.

4.3.2 The e-Facilitation Challenge

The ability of the facilitator to first identify and then respond to any problems is aided in face-to-face meetings by visual and verbal cues, but in dispersed meetings, these are no longer available, especially if they involve groups larger than 50 (White, 2002). There have been recent attempts to address this issue. For example, Alabdulkarim and Macaulay (2007) proposed a facilitation intervention pattern as a way to mitigate typical dysfunctional group dynamics (e.g. dominance by individuals, unequal airtime, withdrawal by individuals, etc.) but within the context of a dispersed environment. The suggested facilitated process comprises data, cues, symptoms, causes and interventions and involves the designer setting up a series of 'thinklets' (Briggs et al., 2003) that could be used to identify problems as they occur by recognizing language cues built upon a data base of previous interactions that have been developed over time. Helquist et al. (2008) take these ideas in a different direction and seek to introduce ICT into the realm of collaborative patterns. Their analysis is built upon an understanding of collaborative decision support systems, which have five core activities. Three overt – diverge, converge and evaluate, with specific activities designed to enable these to take place. The other two are outputs of the other three, specifically 'building understanding' or organize, and

Table 4.2 Facilitation issues in multi-stakeholder processes (Hemmati, 2002)

Reciprocity	Publicity	Non-tyranny	Political equality
Facilitators need to help create an atmosphere that is both open and positive, one which will encourage not only respectful listening but possibly learning and the changing of views among participants, thus enabling participants to share concerns, thoughts and feelings, whilst at the same time making sure that they help the group stay focused	Facilitators need to keep track of everyone's contributions, drawing together aspects of common ground and summarizing, at regular intervals, what has been said. They also need to keep track of which points might be missing in the discussion and to encourage the group to discuss aspects that have not arisen	Sensitivity to different cultural backgrounds of participants will need to be demonstrated and the imposition of a 'way of doing things' based on their own culture avoided	Facilitators have a crucial role to play in ensuring equity in discussions. If a group is to capitalize on diversity then the facilitator needs to stress the benefits of diversity. The modes of communication and decision making depend upon the facilitator encouraging and guiding the group to put them into practice
Participants may well feel the need to be recognized and be part of a group	A process for keeping track of what has been said will enable summarizing and decision making. This would allow participants to look at each other and help create trust	In exploring differences, facilitators should ask problem-solving questions, not judgemental ones, and encourage all participants to do so	Facilitators need to keep to an agreed timetable and speaking times, which need to be the same for everybody, unless there are language difficulties

Table 4.2 (continued)

Reciprocity	Publicity	Non-tyranny	Political equality
Where conflict arises the facilitator should encourage participants to focus on the "positive intent" or "grain effect" in their opponent's position. Active listening works by asking participants to restate opposing view in their own words	Agreement on how the group reports back to significant bodies	When summarizing, differences should be stated clearly, and there should be no pressure to conform. Stating and restating common ground and agreements along the way can help build confidence and momentum	Sensitivity may be required regarding issues part on which participants will need to consult with their constituencies
Agreements on how to deal with participants who do not play by the rules are required prior to the start of the process		Decide upon the form of consensus for taking decisions. Agreement on the willingness to look at the whole package and not block agreement because of disagreement on one point	

increasing agreement or 'building consensus' are enabled through the effective control or suitable facilitation of the primary three.

The gathering of divergent views through a distributed process is not new (see also Lourenco and Costa). Assuming that the necessary technical support is available to ensure secure and reliable traffic between participants in the web environment (e.g. firewalls, security protocols, SSL encryption, compatible web browsers), then the divergence stage would appear to be reasonably straightforward. As Adkins et al. (2004) note:

> the temporally and geographically distributed group structure creates additional requirements. The system must collect and distribute group inputs utilizing a common web browser for the client application because with large groups it is inevitable that certain group members will be participating from a variety of computers. By using a common web browser, with SSL encryption and user ID and password protection, the group can remain private and its activities secure. By using the Internet, the system can take advantage of a worldwide communications infrastructure. By using common, though current web browsers, users are not required to load applications and can participate in the group interactions from any web-enabled system. (Adkins et al., 2004, p. 4.)

With respect to facilitating convergent activities through a distributed process, a potentially fruitful approach is to use a Participant-Driven (PD) approach to convergence as suggested by Helquist et al. (2008). In order to implement such an approach, agreement of the ground rules for participation would be required prior to starting the process. Clearly ground rules for specific situations can vary, but the following are offered by Adkins and Schwarz (2002):

1. Test assumptions and inferences
2. Share all relevant information
3. Use specific examples and agree on what important words mean
4. Explain your reasoning and intent
5. Focus on interests, not position
6. Combine advocacy with enquiry
7. Jointly design next steps and ways to test disagreements
8. Discuss 'undiscussable' issues
9. Use a decision-making rule that generates the level of commitment needed

The wording of such "rules" would have to be tailored to the potential participants so as to ensure the characteristics of a deliberative democratic process as outlined in Section 4.3.1 above might be enabled. This would go in some way to create a 'memorandum of understanding' (Hemmati, 2002, p. 214).

Once the participants have signed up to the rules, the process may begin. The initial part is the collection of individual inputs on the subject area that is deemed relevant to the issue(s) at hand and, as we noted above, this divergence part is not especially new. What is more demanding is the effective enabling of the convergence and evaluation phases, whilst at the same time ensuring that the process is, in some way, enabling consensus and understanding. Helquist et al. (2008) PD approach to convergence entails the participants in engaging in more of the tasks normally associated with the role of the facilitator. Echoing this approach we suggest below a number of activities or ‘modules’ that would be necessary for a collaborative convergence process.

- *Module to evaluate inputs*: Individuals in the group are given the opportunity to review the incoming ideas from the initial brainstorming; this may provide some sense of consensus on what is important and the order in which issues need to be considered. It will also ensure that participants are engaged in the reading of other peoples’ inputs and maybe develop a better understanding of the possible solution space. This module could be used also to remove any erroneous inputs or ambiguous entries – any evaluation process within this module would probably relegate these to lower priorities as people may not understand them.
- *Module to narrow the range of ideas*: These may have occurred through duplication or be similar. Thus, some may be identified as redundant by individual participants, or may need to be combined, which can be opened up to verification by all participants. Their removal can reduce the degree of complication of the decision space, yet maintain its richness.
- *Module to cluster ideas*: Helquist et al. (2008) suggest the use of individuals clustering random subsets of ideas from the narrow range of inputs and then using statistical inference to derive the clusters from the entire set. This might be done by using clustering techniques based upon spatial analogies whereby the participants would be given a subset of random ideas in a “bucket”, then asked to sort their bucket into as many categories as they would like – the system proposed would infer the spatial proximity of the ideas by aggregating across the sorted categories from the participants. This might remove the possibility of anchoring bias; the aggregated effort is more likely to represent group consensus, and it will indicate more clearly the membership of any idea within a given cluster (Kao and Poteet, 2007). This may well be a fast process.
- *Module to name and rename clusters*: Participants work independently and anonymously providing labels for each cluster. This cluster can then be passed on and another person invited to either agree or rename it – this process would continue until a pre-agreed level of consensus was achieved, or a maximum number of iterations were reached.
- *Module to summarize clusters*: the group is required to develop a concise textual summary of each cluster – again this should help provide consensus and better understanding for people outside of the group for each cluster. It will also allow the facilitator to assess the level of consensus of the group.
- *Module for process judgements*: To ensure that the group does not waste time and effort there would be regular enquiries regarding the state of the process and outputs; this could substitute for the usual process judgements that facilitators need to make.

The above six modules could take a variety of forms, dependent upon the nature or purpose of the decision-making element to which they are being addressed (see Table 4.1). It may well also be the case that some elements would go through several iterations as the various phases inherent within a PSM progress.

4.4 Conclusions and Directions for Further Research

This chapter has discussed the issues and problems that might arise in attempting to conduct a deliberative democratic process in a virtual environment, one that entails dispersed participants probably engaging on an asynchronous basis. PSMs have been shown to be of use in problematic situations with multiple actors, often having different views or interpretations of the issues constituting the situation of concern, and have provided a means of combining actors' interpretations and gaining a sufficient degree of consensus to enable them to make progress. PSMs normally entail the use of some aspects common to group facilitation processes with some recognition of the importance of divergence, convergence and evaluation. Such dimensions are dealt with in a live environment with direct interaction between the relevant key stakeholders supported by external facilitation. In this chapter, we have considered the stresses that carrying such activities in a virtual environment will place upon the manner by which a deliberative democratic process might be facilitated.

We noted that certain agreements on participants' behaviour would need to be achieved before the process might begin and that once the initial views and ideas on an issue have been ascertained, some kind of participant-driven convergence and evaluation process would be necessary to ensure that deliberative democratic ideals might be met.

In our view, the key question is whether or not PSMs in a virtual environment can be viewed as a potentially positive aid to deliberative democratic processes? To asses this, we can return to the four characteristics of deliberative democracy offered by Conover and Searing (2005) above: reciprocity, publicity, non-tyranny and political equality. The techniques within the PSM toolkit are designed to offer just such characteristics, but they are normally utilized in small, face-to-face groups. It is our suggestion, however, that the convergence processes that are normally enabled by direct discussion, and with a trained PSM facilitator, can be approximated by making use of participant-driven processes as outlined by Helquist et al. (2008). The biggest danger is participant fatigue, as it will require a number of iterations on each phase of the PSM process to ensure that the democratic nature of deliberations is achieved.

Some future research directions can be identified. First, it needs to be established that PSMs do ensure or enhance the characteristics of deliberative democracy. Secondly, that the activities or modules outlined above, or some variant thereof, are technologically feasible, or might become feasible in the future. And, finally, even if the necessary participants can be found to engage in the process, one cannot be sure that sufficient numbers would be willing to follow the process through to the end.

Concluding, we believe that the deployment of PSMs to support *e*-democratic deliberations is possible but that more research is needed. Technological developments and government pressure for increased citizen participation in democratic deliberations make the need to develop further facilitated problem-structuring approaches an emergent priority in the PSM research agenda. We thus hope that this chapter will stimulate more work in this direction.

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Chapter 5
Decision Support Systems

Simon French

5.1 Introduction

Open any text on information systems or decision support systems (DSS), and you are likely to define a definition of a DSS along the following lines "An interactive information system that provides information, models and data manipulation tools to help make decisions in semi-structured and unstructured situations" (Alter, 2002). Moreover, almost without pause, discussion in such books goes on to discuss decision support from expert systems and database tools which apply in structured situations,[1] thus extending the definition to span all situations, however structured they be. Given that the definition of an information system more often than not suggests that one of its main purposes is to support decision making (Lewis, 1991), one might also wonder whether there are any circumstances in which it would be wrong to describe any information system as a DSS. We shall be more specific. In the next section, we discuss a variety of issues that together provide a typology of DSS in relation to their context of use and the support that they offer. We shall also consider the different parties to decision making: the decision makers themselves, stakeholders, experts and analysts, separating their roles conceptually.

e-Democracy and *e*-participation processes are, because of their resource intensive nature, only used to address the more complex and difficult societal problems. Thus we focus our discussion on decision analytic methodologies designed for such complex problems, considering approaches to sense-making and issue formulation, decision analysis and evaluation, and how these methodologies are embodied in various DSS. Design of a DSS does not simply relate to how to encode the algorithms and processes of decision analysis. There are major issues relating to human computer interaction (HCI) and how the system interfaces with the decision-making

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[1] In fairness to Steve Alter, he was one of the first to recognise a need for a taxonomy of DSS and I would not accuse him of the laxness on thinking about decision support common to much of the information systems literature (Alter, 1977).

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process. We close by noting these and reflecting on their importance in the contexts of *e*-democracy and *e*-participation.

5.2 Categorising Decision Support Systems

5.2.1 The Strategy Pyramid and Cynefin

There are many types of decisions, and they can be categorised in many ways. One popular and useful way is via the strategy pyramid: see Fig. 5.1. Originally this offered a trichotomy of decision contexts: *strategic*, *tactical* and *operational*. A strategic decision sets a direction and a framework in which more detailed decisions can be taken. Tactical and operational decisions fill in those details. However, this categorisation misses one layer of decision making at its base: namely, *recognition primed* or *instinctive* decision making (French et al., 2009; Klein, 1993). Much decision making relates simply to the process of conducting a piece of work, e.g. deciding what and how to do a small part of the task. Such decisions are often taken instinctively, simply an expression of learned, unconscious behaviour and are taken on the basis of recognising the context. The term 'pyramid' simply acknowledges that one is generally faced with many more of the lower decisions in life than the strategic ones, though it is the last that matter the most. Simon (1960) noted that strategic decisions also tend to correspond to ill-formed or unstructured problems. Increasing amounts of structure enter the problem as one passes down the pyramid from tactical through operational to recognition-primed decisions.

Recently Snowden has developed the Cynefin framework, which, in a sense, re-expresses and expands on the strategy pyramid's categorisation of decision contexts, although he developed Cynefin more to discuss knowledge management than decision making (Snowden, 2002; Snowden and Boone, 2007). Figure 5.2a illustrates Snowden's framework and Fig. 5.2b its relationship with the strategy pyramid. Cynefin roughly divides decision contexts into four spaces. In the *known space*, or the Realm of Scientific Knowledge, the relationships between cause and effect are well understood. All systems and behaviours can be fully modelled. The consequences of any course of action can be predicted with near certainty.

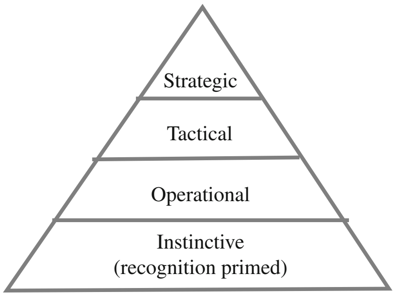

Fig. 5.1 The strategy pyramid

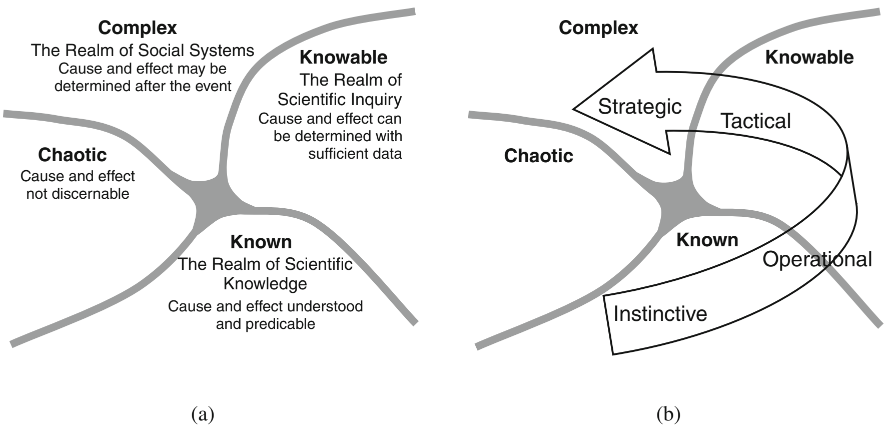

Fig. 5.2 Relationship between the perspectives offered by the strategy pyramid and Cynefin

In such contexts, decision making tends to take the form of recognising patterns and responding to them with well-rehearsed actions, i.e. recognition-primed decision making. Snowden describes decision making in these cases as *categorise and respond*. In the *knowable space*, the Realm of Scientific Inquiry, cause and effect relationships are generally understood, but for any specific decision there is a need to gather and analyse further data before the consequences of any course of action can be predicted with any certainty. Snowden characterises decision making in this space as *sense and respond*.

The *complex space* is often called the Realm of Social Systems – though such complexity can arise in environmental, biological and other contexts. Here decision-making situations involve many interacting causes and effects. Knowledge is at best qualitative: there are simply too many potential interactions to disentangle particular causes and effects. Unlike the known and knowable spaces, there are no precise quantitative models to predict system behaviour. Snowden suggests that in these circumstances decision making will be more of the form: *probe, sense and respond*. Finally, in the *chaotic space* situations involve events and behaviours beyond our current experience and there are no obvious candidates for cause and effect. Decision making cannot be based upon analysis because there are no concepts of how to separate entities and predict their interactions. Decision makers will need to take probing actions and see what happens, until they can make some sort of sense of the situation, gradually drawing the context back into one of the other spaces. Snowden suggests that such decision making can be characterised as *act, sense and respond*. More prosaically, we might say ‘trial and error’ or even ‘poke it and see what happens!’

Note that contexts which fall into the known and knowable spaces are necessarily repeatable or commonly occurring in some sense. Otherwise decision makers and their advisors would not have developed sufficient understanding to infer and test scientific theories and hence build predictive models. Repeatability does not just underpin their understanding of cause and effect in the known and knowable spaces; it also allows them to shape their values quickly, often unconsciously. Familiarity with similar circumstances means that they will know what they want to achieve in any particular decision simply because they 'have been there before'. Contexts in the complex space tend to be novel and certainly they are so in the chaotic space. There are few predictive models to help, and prediction will be more judgementally based. Moreover, the occurrence of novel issues requires decision makers to reflect upon what they want to achieve (see also Slovic, 1995). Thus methods of value focused thinking and the exploration, evolution and elicitation of values, weights and utilities lie at the heart of decision analyses and support in the complex space (French et al., 2009; Keeney, 1992; Keeney and Raiffa, 1976).

Finally, note that the boundaries between the four spaces should not be taken as hard nor, for that matter, the distinctions between strategic, tactical, operational and recognition-primed. The interpretation is much softer with recognition that there are no clear-cut boundaries and, say, some contexts in the knowable space may well have a minority of characteristics more appropriate to the complex space and *vice versa*.

5.2.2 Levels of Support

Cynefin provides a categorisation of decision contexts, and we shall see that different forms of DSS are appropriate to each. But first we need to recognise that different levels of support can be offered by different DSS: see Table 5.1. Some DSS simply organise and present data; others help the decision makers think through their values and beliefs and make sophisticated evaluations which balance these.

Level 0 DSS refers simply to the presentation of data. Such DSS simply presents relevant data from databases and other sources to the decision makers with minimal analysis. Level 1 systems take the available data and combine these with understanding usually expressed through the use of one or more models to forecast how the environment will evolve. Such systems predict the future, but stop short of predicting the consequences of potential interventions. DSS providing support at levels 0 and 1 do not recognise, per se, that the decision makers face a decision. Such systems help the decision makers' understanding grow only in relation to the external

Table 5.1 Levels of decision support

Level 3	Evaluation and ranking of alternative strategies in the face of uncertainty by balancing their respective benefits and disadvantages
Level 2	Simulation and analysis of the consequences of potential strategies; determination of their feasibility and quantification of their benefits and disadvantages
Level 1	Analysis and forecasting of the current and future environment
Level 0	Acquisition, checking and presentation of data, directly or with minimal analysis, to dms

environment, either as it is (Level 0) or as it is likely to evolve (Level 1). Level 2 systems predict the consequences of the various alternative strategies. But, although they may predict the success of alternatives in terms of a number of performance measures, Level 2 systems stop short of helping the decision makers evaluate the overall success of the strategies. They do not support the process of judgement that the decision makers must undergo to make the decision, that is, the province of Level 3 systems, which seek to support the decision makers as they explore, evolve and act upon their judgements. They help decision makers weigh together conflicting criteria and also balance potential benefits and costs with key uncertainties.

5.2.3 Categorisation of Decision Support Systems

Figure 5.3 indicates a rough categorisation of a variety of DSS according to both their Cynefin space and the level of support which they offer. Databases and data mining can provide Level 0 support over all the spaces but are often referred to as management information systems (MIS) or executive information systems (EIS), respectively, in the cases of the knowable and complex spaces (Alter, 2002; Laudon and Laudon, 2009). In the known space, simple simulation and forecasting predict how systems will evolve while, expert systems (ES), neural nets, and other artificial

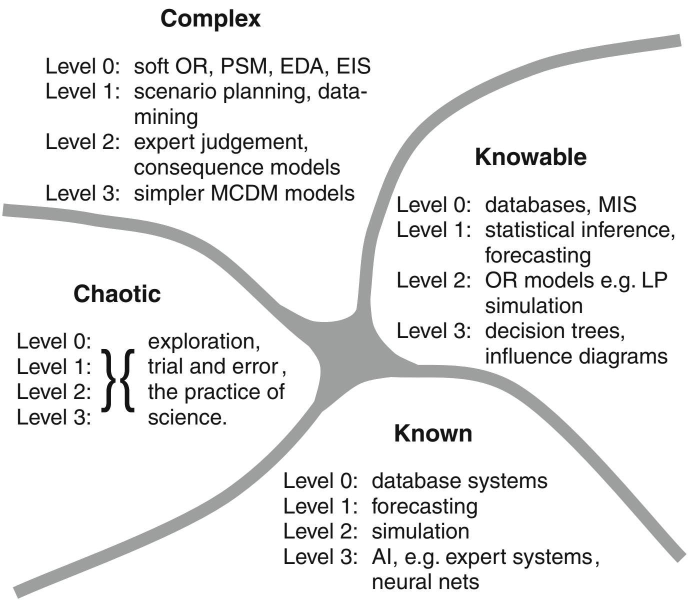

Fig. 5.3 Categorisation of a variety of DSS according to Cynefin space and level of support. *Key*: AI – artificial intelligence; EDA – exploratory data analysis; EIS – executive information system; LP – linear programming; MCDM – multi-criteria decision making; MIS – management information system; OR – operational research; PSM – problem structuring methods

intelligence (AI) techniques provide level 2 and 3 support. Note that some authors suggest that AI-based DSS have a much wider range of application, but such DSS are only really suited to the highly structured and repetitive situations found in the known and perhaps knowable spaces because they need large training sets, based on past data (Edwards et al., 2000; French et al., 2009). Operational research (OR) modelling, e.g. linear programming, inventory models and project planning tools (Denardo, 2002; Taha, 2006) underpin many of the systems used in the knowable space at levels 2 and 3, but OR techniques tend to assume too much structure to be used in the complex space.

Applications of *e*-democracy and *e*-participation almost inevitably are confined to the complex space. Involving the public in any societal decision is an expensive affair not only in terms of monetary cost but also in terms of the opportunity costs of the time involved. Decision making in the known and knowable domains is well enough rehearsed to be left to the administrative organs of government. If systemic departures from the broad values and expectations of the public become apparent, these can be corrected at the next election. Equally decision making in the chaotic space is not a matter for public participation. Here the behaviour of the system is not understood. So if there is no pressing need to take action, the exploration of the system can be left to scientists, economists and social scientists, who will, in time, make sense of what is going on.[2] On the other hand, if the behaviour in the system seems to threaten something untoward in the immediate future, there is a need for crisis response and management and there is no time then for public participation.[3] Thus for the remainder of this article, we consider DSS that is suitable for the complex space. As Fig. 5.4 suggests, for level 0 this will require us to consider tools for problem and issue structuring (PSM), often called soft OR or soft modelling tools (Franco et al., 2006, 2007; French et al., 2009; Mingers and Rosenhead, 2004; Rosenhead and Mingers, 2001); see also **Carreras and Franco**. We will also need to look to exploratory – as opposed to confirmatory –

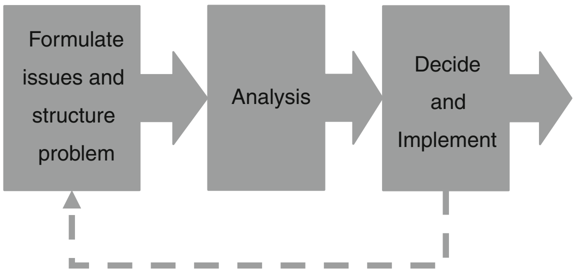

Fig. 5.4 Holtzman's model of a decision process

[2]Although it should be noted that the public are becoming more involved in scientific and other research: see discussion of Science 2.0 (Shneiderman, 2008; Waldrop, 2008).

[3]Although public participation is often involved in the recovery phase after a crisis, but by then the issue has moved from the chaotic to complex space (Niculae and French, 2003).

data analysis (EDA) (Tukey, 1977); such methods are often incorporated into EIS. Modern data-mining techniques which seek to identify patterns in large messes of data may also be appropriate (Hand et al., 2001; Korb and Nicholson, 2004). However, we would emphasise that however routine and automated these procedures seem, they inevitably require judgement to separate interesting and useful patterns from spurious ones. There is not enough repetitivity here to resort to significance tests or the like. DSS providing level 1 or level 2 support will essentially embody processes such as scenario planning (Montibeller et al., 2006; Schoemaker, 1995) or metagames (Howard, 1971), i.e. methodologies that stimulate decision makers to anticipate contingencies and perhaps too some simple consequence modelling. Finally level 3 support will be provided by some of the simpler multi-criteria decision-making models (Belton and Stewart, 2002), such as multi-attribute value analysis (Keeney and Raiffa, 1976), multi-criteria decision aid (Roy, 1996) or the analytic hierarchy process (Saaty, 1980).

It should also be noted that complex problems are usually addressed by a group of decision makers, perhaps supported by a team of experts, rather than a single decision maker. Their very complexity makes it necessary to bring many minds to bear. This means that DSS for the complex space usually support collaboration between the various actors involved in the decision in addition to supporting the decision making itself. Thus they often draw on a range of technologies known as computer-supported co-operative work (CSCW) (Laudon and Laudon, 2009); see also **Efremov and Ríos Insua**.

5.2.4 The Decision-Making Process

The representation in Fig. 5.4, taken from Holtzman (1989), illustrates a commonly agreed structure for a decision process, and we shall use this to structure our perspective on participatory processes; see also **Ríos Insua** and **French**. In the first phase, the aim is to formulate the problem, issues, objectives and options. In this stage, the decision makers need to think divergently, to be creative and innovative in exploring the issues and thinking about how these might be addressed.

In the next phase the aim is to model and analyse these. Thinking needs to become more convergent, as the essence of the issues are captured in a model, or better a family of models. Essentially this involves predicting the consequences of each possible option in terms of how successful they are in achieving the various participants' objectives, taking account of any potential uncertainties in the prediction. Thus the analysis offers guidance towards options that promise to achieve their objectives. In the third phase, the decision makers decide upon which option to implement. This involves interpreting the policies recommended by the analysis phase into real-world actions. Since any model is a simplification of the real world, there will be a need to reflect on the recommendation, and see if it makes sense once the complexity of reality re-enters the discussion. There is a need to assess whether the model(s) have brought enough understanding to make the decision. Thus there may be a feedback or refinement path in Fig. 5.4.

5.2.5 The Actors in a Decision

We should recognise that there can be several types of actors in a decision process, not just the decision makers; but others play a role. We distinguish here experts, stakeholders and analysts. *Decision makers* are responsible for making the decision: they 'own the problem'. In *e*-democracy and *e*-participation contexts, the decision makers may be the whole of society, i.e. the constituency. However, in many circumstances the government or its agency may reserve the legal right to make the decision, but consult very widely and be effectively bound by the outcome of that participation process. The decision makers are accountable to some but not necessarily all the *stakeholders* in the problem. Stakeholders share – or at the very least perceive that they share – the impacts arising from a decision. They have a claim, therefore, that their perceptions and values should be taken into account. The decision makers are stakeholders, if only by virtue of their accountabilities; but stakeholders are not necessarily decision makers. In public sector decision making, the government and its agencies generally have many stakeholders: the public, industry, consumers, political parties, etc. As just noted, it may be the case that the decision makers formally remain the government or its agencies, even though they consult very widely through society.

Experts provide economic, marketing, scientific and other professional advice used to assess the likelihood of the many eventualities. Notwithstanding our use of 'scientific' as opposed to 'economic', etc. in the previous sentence, we shall often adopt the classical use of the term 'science' and use it to refer to a broad range of human knowledge. The information experts impart is used in the modelling and forecasting of the outcomes of various options. The decision makers may have technical advisers who undoubtedly are experts in this sense, but they are unlikely to be the only experts involved. Other experts may advise some of the stakeholders and thus inform the stakeholders' perceptions and hence influence the decision making.

Analysts develop and conduct the analyses, both quantitative and qualitative, which draw together empirical evidence and expert advice to assess the likelihood of the outcomes. They will be concerned also with a synthesis of the stakeholders' value judgements. These analyses are used to inform the decision makers and guide them towards a balanced decision, reflecting the various expert and stakeholder inputs and the emphasis that the decision makers wish to give these. Whereas experts support decision making by providing information – relevant economic data, assessment of physical risks or whatever – on the *content* of the decision, analysts provide *process* skills, helping to structure the analysis and interpret the conclusions.

Note that different actors have different needs of decision support. The decision makers look to a DSS to enhance their understanding of the issues, their uncertainties and their values so that they can balance these and choose a course of action. Experts are concerned only to explore and explain how a system may evolve under a range of possible interventions. Stakeholders need to understand how they may be impacted so that they can explain to the decision makers what matters to them and why. Analysts need support in managing the decision-making process, they need to know where to focus attention and discussion.

5.3 Decision Support Systems for the Complex Space

With the background set in previous sections, we can now discuss in more detail the functionalities provided by different DSS for the complex space, which are especially relevant for *e*-democracy and *e*-participation contexts. We structure this discussion using the three phases indicated in Fig. 5.4.

5.3.1 The Formulation Phase: Support for Divergent Thinking

Herbert Simon (1960) identified that most decision making in the complex space relates to unstructured contexts. The decision makers begin unclear of what the issues are, which are the most important, how to address them and usually what they are trying to achieve in their decision making. Before they can make a decision on what to do, decision makers need to formulate the issues and problem. For centuries – well, since man began to decide – this has been left to intuition and unguided intelligence, but over the past two or three decades there have considerable developments in methodologies for issue and problem structuring. We referred to the literature on these in Section 5.2.3. Here we discuss some of the software available to support this.

As the decision makers, their experts and perhaps their stakeholders become aware that there are some issues that need addressing they may conduct one or more brainstorming sessions (Rickards, 1999). In many cases these will be conducted with flip-charts and post-its, and the only use of technology will be when the results of the session are recorded in a word-processed report; see **Daniell et al**. However, there are a range of group decision support systems (GDSS) which may help. At their simplest brainstorming modules within GDSS simply automate the older post-it and flip-chart approaches to brainstorming. Participants input ideas as they occur to them. The software then projects these up onto a screen in the order that they are entered. However, more subtle approaches have been implemented in which the growing stream of ideas are sent to individual participant's screens in different orders so that each is catalysed with a different sequence; thus, it is hoped that there is a 'widening' of this divergent phase of decision making (Kerr and Murthy, 2004; Nunamaker et al., 1988; Nunamaker et al., 1991). Some systems allow participants to comment on earlier ideas or rather associate them with earlier ideas, instead of simply appending them to the end of the list. It is a somewhat moot point whether computer-supported brainstorming or more plenary vocal sessions have greater overall advantage. The quiet, individual activity in a computer-mediated session can avoid idea blocking, i.e. circumstances in which participants wait to get their idea into the list rather than listen to others' ideas and be catalysed by them (Kerr and Tindale, 2004). However, vocal plenary activity punctuated inevitably by humour can do a wealth of good for team building in the first stages of problem solving. Of course, computer mediated sessions can be managed over the internet without the need for participants to be co-located (French et al., 2008).

Brainstorming methods can be given structure by incorporating check-lists and other prompts such as PESTEL or 7Ss to widen this divergent thinking phase. Moreover, the ideas generated can be structured in a number of ways to connect related ideas and summarise the developing understanding of the concerns and issues. We mention mindmaps, cognitive maps, attribute or value trees, stakeholder plots, influence diagrams and decision trees, but we make no claim that this approaches an exhaustive list. Such methodologies are known under a range of titles: soft systems, soft OR and, recently, problem-structuring methods (PSM). For surveys, see French et al. (2009), Rosenhead and Mingers (2001), Franco et al. (2006, 2007) and **Carreras and Franco**. Such methods, which we discuss a little below, help the decision makers, experts and stakeholders shape their perceptions of the issues. There are many software packages to help in this, some specifically designed for problem and issue formulation (e.g. mindmapping or cognitive mapping software), others also offering support for the later phases of decision making (e.g. decision analysis packages). Furthermore, general drawing packages can be used.

The methods described above help the decision makers and analysts build a range of subjective perspectives on the issues before them. But there is also a need to explore available data sets. For this, there is a range of exploratory methods which display available data sets in ways that may be informative. John Tukey's work in the 1960s and 1970s was seminal in bringing exploratory data analytic (EDA) methods into statistical practice (Tukey, 1977), which until then had been dominated by confirmatory methodologies for estimation and hypothesis testing. Almost all statistical and data analysis packages today offer a range of exploratory tools for displaying the data so that the actors in decision making may be able to see interesting features. Box and whisker plots, comparative pie charts, back to back histograms, simple trend charts, etc are now all common features. Indeed, most spreadsheet and database packages offer the ability to produce some of these plots. Many executive information systems (EIS) provide a range of such plots within a simple 'dashboard' allowing managers of all levels to monitor the effectiveness of processes and their organisations. The key idea in EDA is to look for patterns in the data that are suggestive of underlying behaviour. Over the past 20 years, some of this searching for patterns has been automated by data mining methods drawing on algorithms developed within artificial intelligence. Data mining and EIS are part of *business intelligence* systems which sit on top of organisations' databases, allowing, on the one hand, ongoing performance to be monitored and, on the other as here, changes and novel features to be detected.

We close this part of the discussion by noting that during the formulation stage there is a need for the many actors – decision makers, experts and stakeholders – to interact and share their perspectives and relevant past experiences. Modern knowledge management systems (KMS) provide tools for collaboration and deliberation as well as to search a multitude of databases, reports and files without needing detailed knowledge of the systems in which they are held (Alter, 2002; French et al., 2009; Laudon and Laudon, 2009).

5.3.2 *The Analysis Phase: Support for Convergent Thinking*

As we have noted, in the formulation phase divergent thinking dominates. Ideas are catalysed, captured, commented upon, discussed superficially but neither debated in depth nor examined for consistency. Within the analysis phase, convergent thinking comes to the fore. Consistency is enforced by building models of various forms, and the software needs to encourage a much more structured approach.

There are many different forms of software that can be used in the analysis phase. Firstly, there is usually a need for some form of consequence modelling, i.e. calculations that predict the impacts of a particular action or strategy. In terms of our categorisation of the level of decision support provided (Table 5.1), we need to look to level 2 support. However, while in the known and knowable domains quite detailed and sophisticated models may be used to predict the consequences of particular actions, in the complex space this is seldom possible. Our knowledge of what each action may ultimately bring is necessarily limited by our lack of full understanding of cause and effect. Thus the consequence modelling used may be based more upon quite simple models pulled together in a spreadsheet, general purpose mathematical modelling or system dynamics tool. Generic influence diagram, belief net or decision tree software can be sometimes very helpful here, as they allow interactions between events and actions to be modelled very easily and to whatever depth is commensurate with the decision makers', experts' and stakeholders' knowledge.

However, as we have noted, often the issues are so complex and cause and effect so poorly understood that explicit consequence modelling is impossible. In such cases, one may draw on expert judgement (Cooke, 2007); one simply asks one or more experts to predict the outcomes of strategies using their judgement. Software can help this process by (i) structuring the elicitation of judgement and encouraging consistency (ii) calibrating the experts' judgements against what little data is available and (iii) bringing the expert's judgements together into some sort of consensus.

Level 3 support is generally provided by what is commonly recognised as decision-analytic software. Many of these packages are based upon the multi-attribute value and subjective expected utility paradigms – strictly one paradigm with value functions dealing with circumstances in which uncertainty is not explicitly modelled and utility functions with those in which it is (Keeney, 1992; Keeney and Raiffa, 1976). One might think, with all the uncertainty within the complex space, that it would be normal to use subjective expected utility to support the analysis. Paradoxically, multi-attribute value analysis is more commonly used, particularly in public and stakeholder engagement. There are several reasons for this. Since most situations in the complex space are novel, the participants – decision makers and stakeholders – seldom have a clear idea of their values in this context. They need to think these through; moreover, the tenets of value-focused thinking (Keeney, 1992) require one to do this very early on in the process. Since multi-attribute value modelling forces the users to confront and structure their values, it is a natural starting place for this phase of the decision-making process. Also it provides a means of interacting with stakeholders so that their values may be elicited and conveyed to the decision makers. Uncertainty is, indeed, significant, but often so great that it cannot be modelled in any sophisticated manner and is instead addressed via sensitivity analysis (French, 1995, 2003; Ríos Insua, 1990, 1999). Modern multi-attribute value software generally has a great variety of sensitivity analysis tools built in and usually allows sensitivity explorations to be carried out via intuitive graphical interfaces. If uncertainty is modelled formally, then decision tree or influence diagram software can be used to facilitate the full power of subjective expected utility modelling.

Other paradigms of multi-criteria decision making may be used in place of multi-attribute value and utility modelling. The analytic hierarchy process (Saaty, 1980) is closest in spirit to multi-attribute value modelling. Then there is a range of outranking methodologies stemming from the seminal work of Roy (Roy, 1996; Roy and Vanderpooten, 1997). The International Society on Multi-Criteria Decision Making[4] discusses all such methodologies at its meetings and in the proceedings of those. The *Journal of Multi-Criteria Decision Making* is another useful resource, as is the INFORMS journal *Decision Analysis* though this confines its attention mainly to multi-attribute value and utility analysis.

5.3.3 The Decision

The third phase of the decision-making process (Fig. 5.4) is to make the actual decision and implement it. The decision belongs to the decision makers and they must reach agreement on what to do. Voting tools are very easy to implement in GDSS, and there is much software available to do this. A sad comment because voting is not a simple and as logically consistent process as is commonly believed (French, 2007). Over half a century ago, Kenneth Arrow showed that there can be no voting system that is both democratic and leads to rational decision making (Arrow, 1963). Others have gone on to show that all voting systems have the potential for manipulability – i.e. strategic voting or worse: see **Nurmi**. The conclusion of this work is either one selects a voting system that has the main qualities that a group or society values and lives with its potential faults or one takes a different perspective and sees a group of decision makers as a social process which draws together the individual decisions of its members (Dryzek and List, 2003; French et al., 2009). This latter route, which includes systems which support negotiation between the participants (see **Benyoucef**), is difficult enough to manage in small groups and is a huge challenge to manage in public and stakeholder participation applications when very many people are involved. Current GDSS which manage such processes are all built on the assumption that small groups are involved. Web 2.0 social networking applications which are targeted at much larger groups have yet to address the issues. For further discussions of collaboration systems and GDSS, see **Efremov and Ríos Insua**.

[4] http://www.mcdmsociety.org/

One technology we should mention in this context is that of explanation systems. It is well established that any advice particularly from an ‘inanimate’ DSS is much more persuasive and accepted if an explanation of the underlying reasoning is provided (Swartout, 1990). Thus some DSS have explanation functions which take the multi-attribute value model or whatever and translate the conclusions of the analysis and how this is built on the inputs from mathematics into plain everyday language (Klein, 1994): see **Geldermann**.

The implementation phase is important in public and stakeholder participation only in so far as they need to be kept informed of what is happening. Detailed project and operational management of the implemented strategy falls back almost inevitably on the authorities concerned. We mention, however, that there are DSS which take the decision and support the implementation plan (Borges et al., 2005; Borges et al., 2006).

5.4 Interface Issues in Decision Support

The effective use of any DSS requires not only that the data and judgements are collected and elicited from the decision makers, experts and stakeholders, then analysed and the results displayed back but also that the users understand – both individually and as a group – what their interactions with the system means. Asking someone to give a weight for the importance of a criteria or a probability to encode their uncertainty is sensible only if these quantities are meaningful operationally and cognitively to the users. For public participation contexts such human-computer interface issues are particularly challenging. When DSS are used within organisations, the users usually share a common culture, at least in relation to the organisation’s business, and they can be provided with training and support. When the users are drawn from all quarters of society, neither of these is the case. So what are the main HCI issues that arise in the use of a DSS?

Firstly, we should remember that we have divided actors in a decision-making process into four groups: decision makers, stakeholders, experts and analysts. These groups have different skills, availability and, above all, needs of the interface (Belton and Hodgkin, 1999; French and Xu, 2005). A DSS *supports* decision makers; it does *not* take the decision. Thus, if the decision makers are to take the decision themselves they need a good understanding of the balance of all the uncertainties and factors. Stakeholders need to understand this balance too, but perhaps more they need reassurance that their concerns have been considered and accounted for. Neither of these groups is likely to be experts in decision analysis; nor are they likely as a group to be skilled quantitatively. Thus, the interface needs to be simple and intuitive to them. On the other hand, experts and analysts need software that helps them technically. The experts broadly will understand the technical details of what they are being asked and the results that they are being shown, though they may need training to encode their uncertainties probabilistically or in any other formalism of uncertainty (Cooke and Goossens, 2000, 2004). The analyst – surely! –

will understand all the technical concepts and formalism of the underlying decision methodology, and their professionalism will ensure that they acquire a good understanding of the content of the decision; however, they also need the software to provide process guidance. For example, French (2003) categorises the various uses of sensitivity analysis in the different phases of decision making and shows that there are specific points at which the analyst needs more information that other users.

French et al. (2009) survey and discuss wider HCI issues relating to DSS. Here we focus on those that seem particularly important in designing systems that will have many public users. For issues relating to the design of specific interfaces for experts and analysts, we refer the reader to the literature.

Input screens that elicit judgements from the user should do the following:

- ask questions that are cognitively meaningful using *their* language and in the case of lay users, avoiding technicalities;
- check for and help the user avoid judgemental biases (Kahneman and Tversky, 2000; Kahneman et al., 1982);
- ask questions about real observable entities not some abstract modelling construct such as a parameter so that the user can relate their responses to their experience;
- use relatively simple scales and appropriate accuracy – human judgement is not accurate to the third significant figure;
- focus the users' efforts on the things that really matter and not exhaust them by requesting for too many judgements.

Similarly, the output screens should do the following:

- provide the results in the users' language and make use of graphics that are intuitive to them – specifically using metaphors familiar to the users and not those of technical experts and analysts;
- be wary of misleading users through poor framing;
- avoid over-cluttering the screen, as too much detail can distract from what is important;
- give numerical output to appropriate and useable precision;
- watch wording, symbols and colour for wanted associations, e.g. red means danger, stop in the Anglo-American society but luck in the Chinese one.

We repeat that in organisations, while these points are important, they can be overcome by appropriate training. In *e*-participation and *e*-democracy this is not so easy.

Grudin (1994) listed several challenges for GDSS and, although these may have been largely overcome in systems built for small group and organisational use, for societal use they remain problems.

- There can be a disparity in work and benefits, with systems often requiring input from some users who do not themselves receive any immediate benefit from the system. For instance, stakeholders may be asked for their preferences some considerable time before they see any output from the decision process.

- Some systems simply cannot work fully until a sufficient number of users have entered data and judgements. Online polling, for example, only becomes meaningful when sufficient numbers of citizens have responded. Early responders get no or misleading feedback, therefore, while later ones can get an immediate impression of general views. Similarly, early users of a deliberation tool may shape a debate but may see no responses for some time.
- Effective use of a DSS usually requires ongoing changes in practices. In our settings, users may need to disrupt a series of evenings to use the DSS and enter into the ongoing deliberations. This is a much more solitary behaviour than debating at a Town Hall meeting.
- Inevitably there will be issues that cannot be handled effectively by the system, and these need to be anticipated and procedures developed to handle such exceptions.
- The users will, one hopes, understand what helps them and how the information provided by the system affects their perceptions but may lack the intuition to understand how others use the system and what they gain from it. Thus the system might not build the social bridges that deliberative democracy seeks.
- There is a considerable problem in training users. Firstly, this almost inevitably has to be done online in the contexts that we are considering and that itself is a challenge, as decision analysis is not the easiest mode of thought to teach. Moreover, it may be necessary to train several simultaneously so that they can explore the CSCW aspects of the system.

Lastly there is an issue that we may ponder through this book; one that extends far beyond the HCI of DSS. It is notoriously difficult within organisations to evaluate DSS, even for those organisations driven by a clearly defined bottom line. In societal terms, evaluating the contribution of a DSS to an *e*-participation or *e*-democracy process is a largely unaddressed problem (Zhang, 2008).

5.5 Concluding Remarks

As we have indicated at many places, this review of DSS has been very partial and focused on those technologies that may find application in *e*-participation and *e*-democracy contexts. Moreover, we have emphasised a categorisation of DSS which relates to their functionality in terms of level of support and the type of decision supported. Other authors categorise systems by their underlying technology.

The literature on decision support divides, by and large, into two categories: that which explores the underpinning processes and analysis without specific regard to the software per se and more software engineering texts which discuss the structure and design of DSS from that perspective. In the former category, we mention

Clemen and Reilly (2004), Denardo (2002), Goodwin and Wright (2003) and Taha (2006); in the latter, Turban et al. (2007) and Mallach (2000). A few books, however, do try to span both perspectives: e.g. French et al. (2009) and Marakas (2003). The *Handbook on Decision Support Systems* (Burstein and Holsapple, 2008) is encyclopaedic in its coverage.

We have said very little in this chapter about specific decision support software. There is simply too much software available to survey anything other than partially and, moreover, the range available changes quickly. However, we recommend the INFORMS journal *OR/MS Today*. Each month this carries a review of software of a specific type and also one or two in-depth reviews by OR practitioners who examine the functionality of the software from professional analyst's perspectives. In particular, there is a series of biennial reviews on decision analytic software (e.g., Maxwell, 2006, 2008).

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Chapter 6
Collaborative Decision Analysis and *e*-Democracy

Roman Efremov and David Ríos Insua

6.1 Introduction

The essence of *e*-democracy refers to involving groups of citizens in public policy decision making through electronic means. As described in **Arenilla** and **Lavín and Ríos Insua,** this may be done by implementing standard political approaches based on debating and voting, or through more innovative participatory instruments, combining various tasks such as negotiating, preference modelling or information sharing.

In this chapter, we shall review the more analytically oriented tasks included in participatory instruments. Other chapters have referred to supporting other tasks like **Lourenco and Costa** (debating), **Nurmi** (voting) or **Carreras and Franco** (problem structuring). Thus, we describe group decision support approaches which assume that participants adopt a decision-analytic style, as in **French,** and study them from the perspective of their implementation through the web to support large groups of potentially heterogeneous and not highly skilled participants. Gregory et al. (2005) have described many applications of some of the methods here presented in public policy decision making, whereas Ríos and Ríos Insua (2008) describe their use for participatory budgeting, without appealing to Information and Communication Technology.

Collectively, we shall refer to those methods as collaborative decision analysis (CDA), see Raiffa et al. (2002). By CDA, we understand a group-decision-making problem in which decision makers somehow collaborate and are willing to get analytic support. Whereas in individual decision analysis, decision makers try to maximise their value (expected utility); collaborative decision making emphasises cooperation to, somehow, maximise joint value. As we shall see, there is actually no unique, general, way to proceed from individual decision analyses to a group analysis. This is due to Arrow's impossibility theorem (Arrow, 1951) or one of its variants (see **Nurmi)** which states that there are no preference aggregation methods that are unequivocally rational and democratic.

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We shall first outline five key approaches to collaborative decision analysis and then relax some of their entailed assumptions, describing some alternative approaches. We then discuss them in the light of their use for *e*-democracy, in reference to democratic theories, Arrow's theorem, ease of implementation and scalability. We end up with some comments.

6.2 Collaborative Decision Analysis Approaches

In this section, we outline the five main approaches to CDA, focusing on those based on individuals which are expected utility maximisers, as described in **French**. The first three initially work with individuals and, then, somehow, aggregate their analyses, whereas the two latter describe group processes. We use the same notation as in **Ríos Insua and French.** The generic problem we consider may be described as follows: a group must choose a decision from a set A of alternatives, when there are two or more possible future events, called states of nature, uncontrolled by the group. We denote by Ω the space of all possible states of nature, only one of them will come true. Each pair (a, θ) will yield several consequences in the objective space, that is, a function $c: A \times \Omega \rightarrow \nabla^d$ is given.

6.2.1 Preference-Based Voting

The first approach to CDA works with each individual and develops a personal decision analysis to guide their choice by eliciting each member's subjective probabilities over the states of nature, $p^i(\theta)$, $i = 1, \ldots, n$, and utilities over consequences, $u^i(a, \theta)$, $i = 1, \ldots, n$. In light of this, each individual votes within the group, and a group choice is made according to the vote. A voting procedure is defined as a rule to combine individual's rankings in a complete and transitive order for the group. The implementation would clearly depend on the voting rule chosen, see **Nurmi.** Normally, it is distinguished between ordinal voting, as in the majority rule, which only uses ordinal preference information, and cardinal voting, as in approval voting, in which the numerical values of the individuals' expected utilities are used to indicate strength of preference and this information is incorporated into the voting. Some examples would be as follows:

- *Majority rule.* Agent i votes the action maximising his expected utility $\Psi_i(a) = \max_a \int u^i(a, \theta) p^i(\theta) \mathrm{d}\theta$. The action with the biggest number of votes is chosen.
- *Approval voting.* Agent i chooses a threshold utility value λ_i and votes for all alternatives a satisfying $\Psi_i(a) > \lambda_i$. The action obtaining the highest number of votes is chosen.
- *Borda count.* Each agent scores the alternatives from A according to their expected utility $\Psi_i(a)$, assigning to the best alternative, the score $|A|$, where $|A|$ denotes the (finite) number of alternatives in A; to the second best alternative, the

score $|A| - 1$, and so on, until the worst one, which is assigned score 1. The scores for each alternative are summed up across all participants. An alternative with the biggest score is chosen.

Other voting rules could be implemented following this scheme. Many of them are reviewed in **Nurmi**. We will refer to this approach as GDM_{vote} throughout this chapter. GDM_{vote} studies properties satisfied by specific voting rules as well as conditions under which a voting rule satisfying a set of reasonable requirements exists. While voting is quite well understood by participants and easy to use in very large groups, it can be subject to manipulation and, more importantly, it suffers from Arrow's impossibility theorem. Note that, in our approach, prior to voting, participants would need to think deeply about their preferences, thus the name we provide.

6.2.2 Explicit Preference Aggregation

The second approach, see, e.g. Bacharach (1975), French (1985) and Luce and Raiffa (1957) uses *explicit preference aggregation*, which involves the following:

- eliciting each participant's subjective probabilities and utilities, $p^i(\theta)$, $u^i(a,\theta)$, $i = 1, \ldots, n$.
- combining the individual probabilities into group probabilities $p^g(\theta) = \pi\left(p^1(\theta), p^2(\theta), \ldots p^n(\theta), \theta\right)$,
- combining the individual utilities into group utilities $u^g(a,y)$ by building $u^g(a,\theta) = U(u^1(a,\theta), u^2(a,\theta), \ldots, u^n(a,\theta), \theta)$,
- forming the group expected utilities from these, and
- choosing according to their ranking, solving the problem

$$\max_a \int u^g(a,\theta)p^g(\theta)\mathrm{d}\theta.$$

Alternatively, aggregation might take place at the expected utility level, i.e. by aggregating the expected utilities of various agents into some kind of scoring.

The function $\pi\left(p^1(\theta), p^2(\theta), \ldots p^n(\theta), \theta\right)$ is called *opinion pool* or *group consensus probability distribution*. The most popular pools are the *linear* opinion pool; see Stone (1961)

$$p^g(\theta) = \sum_{i=1}^{n} w_i p^i(\theta), \ \sum_{i=1}^{n} w_i = 1, \ w_i \geq 0,$$

and the *logarithmic* opinion pool, see Genest (1984),

$$p^g(\theta) = k \times \prod_{i=1}^{n} \left(p^i(\theta)\right)^{w_i}, w_i \geq 0, \ k \text{ is a normalization constant},$$

The w_i's are viewed as weights that should take into account the relative expertise and power of participants, although it is not easy to define them operationally. Other opinion pools exist; see Genest and Zidek (1986) for a review. More properties as well as drawbacks of these opinion pools are discussed, e.g., in French and Ríos Insua (2000).

Usually, one of two forms for group utilities, or *group consensus utilities*, is considered; see Keeney and Raiffa (1976):

1. *additive*, given by

$$u^g(a,\theta) = \sum_{i=1}^{n} \lambda_i u^i(a,\theta), \text{ with } \lambda_i \geq 0. \tag{1}$$

where the λ_i's are scaling factors.

2. *multiplicative*, given by

$$\lambda u^g(a,\theta) + 1 = \prod_{i=1}^{n} [\lambda\lambda_i u_i(a,\theta) + 1], \tag{2}$$

where the λ_i's are scaling factors and λ is a scaling constant which is a solution to $1 + \lambda = \prod_{i=1}^{n} (1 + \lambda\lambda_i)$.

These simple forms are possible at the cost of some restrictions on the individual utilities (see Keeney and Raiffa (1976, Chapter 10) for full details, which draw on the analogy between multi-attribute utility functions and group utility functions. We will need some notation in order to introduce them briefly. Note that the group utility can be represented as a function $u^g = U(U_i, U_1, \ldots, U_{i-1}, U_{i+1}, U_n, \theta)$, where U_i designates the i-th individual utility. Let $\overline{U}_i = (U_1, ..., U_{i-1}, U_{i+1}, ..., U_n)$, that is, $u^g = U(U_i, \overline{U}_i, \theta)$. Let $[x, p, y]$ be a lottery in which an individual gets a vector of consequences x with probability p and y with probability $1 - p$. The individual may prefer one lottery to another or be indifferent between two lotteries: $[x, p, y] \sim [w, q, z]$, where w and z are other vectors of consequences. If $q = 1$, then the individual is indifferent between the lottery $[x, p, y]$ and the sure thing w. Then, $u^g(a,\theta)$will have the multiplicative form if two assumptions hold:

- for any fixed level of $\overline{U}_i$, which we will denote $\overline{U_i^+}$, the *strategic equivalence* of the utility functions $u^g = U(u^i(a,\theta), \overline{U_i^+}, \theta)$and $u^i(a,\theta)$ holds, which means that they induce the same preference ranking for any two lotteries on consequences $c(a, \theta)$;
- the *independence of utility* of each agent i from the subset of utilities of the remaining agents. This means that if we consider lotteries on U_i given $\overline{U}_i$ fixed, the preferences for the lotteries do not depend on the values we fixed, that is, for any U'_i, U'_j and $\bar{U}_i^+$,$\bar{U}_i^*$ holds:

$$[(U'_i, \bar{U}_i^+), p, (U''_i, \bar{U}_i^+)] \sim [(U'_i, \bar{U}_i^*), p, (U''_i, \bar{U}_i^*)],$$

where $\bar{U}_i^+, \bar{U}_i^*$ are some fixed levels of $\overline{U}_i$.

For the group utility function to be additive, *additive independence* must also hold. This means that the following should hold for every U'_i, U'_j, U''_i, U''_j and $\bar{U}_{ij}^+$, where $\bar{U}_{ij} = (U_1, \ldots, U_i, \ldots, U_j, \ldots, \ldots U_n)$ and $\bar{U}_{ij}^+$ is any fixed level of $\overline{U}_{ij}$:

$$[(U'_i, U'_j, \bar{U}_{ij}^+), \frac{1}{2}, (U''_i, U''_j, \bar{U}_{ij}^+)] \sim [(U'_i, U''_j, \bar{U}_{ij}^+), \frac{1}{2}, (U''_i, U'_j, \bar{U}_{ij}^+)].$$

Explicit aggregation of individual's preferences and beliefs can be viewed in the light of two different perspectives: authority-based and axiomatic-based aggregation.

6.2.2.1 Authority-Based Aggregation

Authority aggregation is made from the perspective of a single "supra decision maker" (SDM), imagined to exist, who has the authority to make the decision on behalf of the group and wants to consider the preferences of the group members in his decision analysis. He observes the entire elicitation and decision-analysis process for each individual and uses this knowledge to construct a single decision analysis for the group. The choice is made according to the supra decision maker's analysis (Genest and Zidek, 1986; Keeney and Raiffa, 1976). Mathematically, the SDM forms a prior distribution $p^s(\theta)$ and the appropriate likelihood for the participants' opinion $l(p_1, p_2, \ldots, p_n|\theta)$. He then treats the stated opinions of the group as data and updates his prior via Bayes' theorem:

$$p^g(\theta) = p^s(\theta|p_1, p_2, \ldots, p_n) \propto p^s(\theta) l(p_1, p_2, \ldots, p_n|\theta),$$

Note that, here, the pooling operator is simply Bayes' rule and the SDM's posterior is the consensus distribution.

As for the group utility, it is formed by the SDM on the basis of the utilities of the participants. The most used forms for the group utility are the additive or multiplicative forms described above. The scaling constants, that is, the λ's in (1) and (2) are assessed by the SDM. As Keeney and Raiffa (1976) noticed, this implies that the supra decision maker is involved in trading off the utility of one participant against another one, which is related with the philosophically controversial issue of interpersonal utility comparisons; see French (1986) for further details.

After the group probability and utility are assessed, the expected utility is found and maximised. We shall designate this approach as $\text{GDM}_{\text{supraDM}}$.

6.2.2.2 Axiomatic-Based Aggregation

Axiomatic aggregation may be used when the group shares the responsibility for decision making. An equity-based axiomatic aggregating procedure may be used here to compute a group choice. It requires that the group accepts and agrees on the axiomatic basis for the procedure before its use.

The axiomatic approach for aggregation of expected utilities provides solutions that satisfy some desired properties that incarnate ideas of rationality and fairness. It is assumed that the participants are willing to cooperate, within the limits specified by the properties concerning the concepts involved. Given the expected utility functions of the participants, let $S = \Psi(A)$ be the bargaining set, that is, the set of attainable expected utilities for the participants. Let d be the status-quo, that is, the utility attained by agents if no agreement is reached. The pair (S, d) is called a bargaining problem. Let $f = f(S, d)$ be a solution of the bargaining problem. Nash (1950) proved that, under the assumption that S is convex, the only bargaining solution that satisfies the five axioms: (1) the solution is Pareto optimal; (2) the solution is better than the status quo; (3) the solution satisfies a symmetry property; (4) the solution is independent from the scales chosen by agents; and, (5) the solution is independent of irrelevant alternatives, is the one that maximises the product of the participants' expected utilities (relatively to the disagreement point):

$$f_N(S,d) = \underset{a \in A}{\operatorname{argmax}} \prod_{i=1}^{n} (\Psi_i(a) - d_i) \tag{3}$$

Nash showed for the first time how the connection between a set of qualitative fairness axioms and a mathematical formula for computing group decisions can be established.

Nevertheless, some (or all) principles of rationality/fairness can be called into question. In particular, the Independence of Irrelevant Alternatives (IIA) was severely criticised, and another well-known solution was proposed that does not rely on IIA (Kalai and Smorodinsky, 1977) which, for the case of a continuous bargaining set S, has a simple geometric form: let b be the bliss point, that is, the point whose coordinates are the maximum expected utilities for each participant, this point being usually unachievable. The Kalai-Smorodinsky solution is the point where the Pareto boundary of S and the segment between d and b intersect.

Some other well-known bargaining solutions are

- utilitarian:

$$f_U(S,d) = \underset{a \in S}{\operatorname{argmax}} \sum_{i=1}^{n} \Psi_i(a).$$

- egalitarian:

$$f_E(S,d) = \underset{a \in S}{\operatorname{argmax}} \min_{i=1}^{n} \Psi_i(a).$$

A good review of solutions and their axiomatisations can be found in Thomson (1994). One could say that there is a spectrum of bargaining solutions, from the utilitarian, which incarnates the principle of major profit (you should do this for me because the gain that this suggests for me is more than the loss that this suggests for you), to egalitarian, which incarnates the principle of equal gains (you should do it for me because I am doing more for you).

The advantage of the bargaining approach is that it can be automatically implemented and, thus, be used in tactical planning. Moreover it guarantees the result to satisfy a priori given principles of fairness. Should the participants accept these principles, the solution should satisfy them. The drawback, however, is that different actors may wish to choose different fairness principles. We shall call this approach GDM_{SEU}.

6.2.3 Decision Conferencing

Organising group discussions with the help of a facilitator (a consultant) is an approach that appears to be very promising in strategic group decision-making practice. *Decision conferences* (Phillips, 1984) are the best known example in this direction. They are intended to find a real consensus within a group. Briefly, a decision conference consists of the following. The group is gathered together in a facilitated discussion of issues, with the aid of a facilitator; see **Carreras and Franco**. Through discussion, the members try to agree on group probabilities and utilities without formally eliciting individual ones. Sensitivity analysis tools are used to explore and dilute areas of disagreement, trying to reach a decision by consensus without formal voting; see e.g. Eden and Radford (1990) or French (1988, 2003) for detailed discussion.

Decision conferences implement the *requisite decision modelling* (Phillips, 1984) concept. A requisite decision model is broadly defined as a model whose form and content are deemed sufficient to solve a particular problem by the agents. This means that the model is iteratively specified more precisely until a requisite, but not necessarily "optimal", solution can be chosen. *Sensitivity analysis* (Ríos Insua, 1990, and **Danielson et al.**) plays a crucial role in developing requisite models; see Phillips (1982). Altering individual assessments allows disagreements between individuals to be examined to see whether they truly make a difference in the final results. Thus, participants may disagree about uncertainties and preferences, i.e. their individual probabilities and utilities may differ, but an agreement can still be reached. On the other hand, changing one or more assessments over ranges of plausible values helps to identify crucial variables in the model.

Note, however, that requisite decisions for each participant do not mean requisite decisions for the group (French, 2003): each individual's model may provide him with a requisite decision. However, the sensitivity analysis for the entire group may show incompatibility of the group members' subjective probabilities and utilities as to provide the group with a decision. In this case, individuals' subjective probabilities and utilities should be modified, according to the crucial variables reported by sensitivity analysis.

The success of decision conferences has impressive results on the corporate activity. Even relative success can influence strategic choices. The drawback is that the failure of a decision conference also has a strong, but negative, effect, strengthening the disagreements and divergent opinions. We denote this approach as $\mathrm{GDM}_{\mathrm{FAC}}$.

6.2.4 Negotiation Analysis

Negotiation analysis models may be deployed to define a process in which the group interacts and discusses a series of solutions, usually generated to reach an acceptable agreement (Raiffa et al., 2002). We describe this in some detail. See **Benyoucef** for additional input.

Negotiation analysis stands frequently for the preparation stage of negotiations. In a more recent view, negotiation analysis provides an "asymmetrical descriptive/prescriptive approach" giving partisan (prescriptive) advice to one decision maker in a group assuming a probabilistic description of what the other individuals might do; see Raiffa et al. (2002). Two types of negotiations are usually distinguished: *distributive negotiations*, which consist of dividing one good and getting the "greater part of the pie; and, *integrative negotiations*, which try to integrate participants' capacities and resources in order to "enlarge the pie" (and, then, claim value). The pie could be multi-issue. Note also that the frontier between both types of negotiations is not always clear since many real negotiations show characteristics of both of them.

The success of a negotiation depends on how precisely one estimates the following parameters before entering into a negotiation (Fisher and Ury, 1981):

1. *Best alternative to a negotiated agreement* (BATNA), which is the course of action that will be taken by a party if the current negotiation fails and an agreement cannot be reached;
2. *Reservation price*, is, in its origin, a microeconomics term and means the maximum buying (minimum selling) price for a buyer (seller). In multi-issue negotiations, the reservation price means a contract that a participant cannot admit to be worse on any issue.
3. The *Zone of Possible Agreement* (ZOPA) is an intellectual zone between several parties that contains alternative solutions that all parties can agree to.

In multi-issue negotiations, each issue can take several resolution levels. A set of all issues with their levels fixed is called a contract. Value is created by exchanges: a level for one issue is exchanged for a level on another issue. To facilitate this process, templates could be used; see Raiffa et al., 2002, Chapter 14. The stages of development of an integrative negotiation are as follows:

1. Each part studies its interests, goals and visions on its own. This analysis helps the parts to understand their BATNA and Reservation Price. At this stage, each party also obtains information on other parties' interests, alternatives and negotiation style.
2. Parties meet together for informal dialog, which consists of selective information sharing, establishing relationships and brainstorming. If there is a go-ahead, participants will jointly decide a future agreement. Here is where developing a negotiation template is very useful. The template consists of all issues that are decided during the negotiations, together with possible resolutions levels.
3. Each party privately evaluates the template, while clarifying its preferences. The advantage of the template is that the parties have a common "negotiation map", where each party can recognise its position, i.e. its aspiration level (and aspiration levels of other parties), as well as its reservation price. After the template is evaluated by each party they gather for the final negotiations, the template helps them immediately accept or reject any of the possible negotiation outcomes.

The scheme described above is best implemented in a Fully Open and Truthful Intermediary Disclosure (FOTID) framework, where the participants disclose their BATNA, reservation prices and quantitative information about their preferences (if any) to a third trusted party, many times a computerised one; see **Benyoucef**. In this case, two general negotiation approaches can be applied: Single-Text Negotiation and Consensus-based methods, which we describe below. Besides, if the participants accept to exchange their reservation prices and provide quantitative analysis of their preferences (the so- called Fully Open and Truthful Exchange (FOTE) framework), the efficient contracts can be calculated and arbitration concepts could be applied in the framework of the two above-mentioned approaches. Moreover, a third group of methods, Joint Gains, can be also applied. Here we give the descriptions of the three approaches; see Kersten (2001) for more details:

- A *Single-Text Negotiation* (STN) process can be described as follows: the negotiators first make a draft which has resolutions on all issues, that is, this draft is mutually feasible and can be immediately implemented. However, as this draft reflects the opposite views of negotiators, it is usually inadmissible for one or more of the parties. In such a way, the parties are advised to change some resolutions on some issues so as to not allow their respective positions to deteriorate. This leads to another single-text that is examined for admissibility by the parties. The procedure goes on until each party approves a revised single text or renounces and obtains the status quo. The Balanced-Increment Solution (BIS) (see Raiffa (1953)) provides a normative model for STN and ensures that the negotiation outcome is weak Pareto-efficient in the sense of expected utilities of the participants. It has been axiomatised, e.g. Livne (1988), under the assumptions of continuity of the feasible set and sufficient smoothness of its boundary. Various applications use the discrete BIS, e.g., in participatory budgeting decision support; see Ríos and Ríos Insua (2008).

- In *Concession-based methods*, the parties start the negotiation from separate positions. They are supposed to make concessions from their current positions until they finally reach each other. The balanced concession solution (BCS) models a negotiation that starts from the bliss point in the participants' expected utility space, that is, the point that corresponds to the best achievements each party can make in negotiations, which is usually unachievable. Thus, the parties are advised to concede mutually so as to approach the feasible frontier. If they do not reach it, they will mutually concede again and will do so until they reach it or give up negotiating. This process is modelled by the BCS; see Ríos and Ríos Insua (2010), which provides a normative model for this kind of negotiations and ensures the final point to be weak Pareto-efficient in the sense of expected utilities of the participants.
- The *Joint Gains* methods (see Kettunen and Ehtamo (1999)) is based on the Method of Improving Directions (see Ehtamo et al. (2000)), which is an interactive method for reaching efficient alternatives, searching from a given initial alternative. The participants start from some feasible alternative. In the mediation process, participants are given simple tasks based on comparing pairs of alternatives. A series of such tasks identifies most preferred direction for each participant in the objective space. These directions are then averaged into a jointly improving direction. An optimisation task is used to find a candidate for a jointly improving alternative. If the participants prefer the candidate to the current alternative, the former becomes the next current alternative, and the procedure repeats until the participants cannot move from the current one.

In the following discussion, we refer to this approach as $\mathrm{GDM}_{\mathrm{NEG}}$.

6.3 Relaxing the Assumptions

In this section, we consider approaches which are not as behaviourally demanding as those described before, which entail eliciting preferences and beliefs before proceeding with further analysis. We focus on two types of approaches: one in which the agents only provide their goals, rather than their beliefs and preferences and one in which they only provide constraints on their beliefs and preferences.

6.3.1 Goal Programming

Goal programming consists of providing aspiration levels for all objectives of the problem and subsequently calculating the nearest alternative. It is one of the key approaches in multi-objective decision making. As indicating aspiration levels is a relatively simple task, goal programming methods have found broad applications, see e.g. Charnes and Cooper (1961) or Ignizio (1985). Note, however, that the aspiration level would generally be provided with little knowledge about the feasible set of objective vectors of the problem. This is further complicated if the problem is under uncertainty. This may result in aspiration levels that are over-optimistic or over-pessimistic with respect to real possibilities and the solution highly dependent from the type of distance that is applied in order to find the nearest alternative.

This drawback may be mitigated in two ways. The first consists of interactively improving the user's aspiration levels so that they can finally describe appropriately his preferences: the initial user aspirations are elicited and the corresponding solution is calculated. After that, in a dialogue phase, the user expresses his preferences regarding the initial solution, e.g., what objective values he would like to improve. Then, the method searches for another solution, according to the new preferences, and so on until a requisite solution is found; see, e.g. Miettinen (1999) or Steuer (1986). The second approach consists of informing the participants about the Pareto frontier, see Cohon (1978), Steuer (1986) or Miettinen (1999). The Pareto frontier is approximated, e.g., with a set of points, and the points are presented to the user. The most effective approach is to combine an interactive method with visualisations of the Pareto frontier, see Lotov et al. (2004).

The goal programming approach may be used in CDA: after the participants have chosen their goals, they are somehow combined to obtain a group goal. One approach consists of averaging the goals: first, find the gravity centre of the participants' goals, and, second, draw the gravity centre near the Pareto frontier, using optimisation techniques. Another approach consists of considering the participants' goals as maxima of their corresponding expected utility functions. First, a parametric class of utility functions is chosen and the parameters are estimated based on the participants' goals. After that, the group utility function is chosen from the parametric class by averaging the parameters of the participants' utility functions. Finally, a point on the Pareto frontier is found which maximises the group utility function. See Efremov et al. (2009) for additional details.

6.3.2 Robust Bayesian Analysis

Robust Bayesian analysis (see Ríos Insua and Ruggeri (2000)) is another approach that mitigates cognitive demands on DMs. In this case, the *i*-th DM is not required to provide precise utilities and probabilities, but just constraints on them, say $u_i \in \cup_i$ and $p_i \in P_i$. We may then determine common grounds through $U = \cap U_i$ and $P = \cap P_i$. These sets of utilities and probabilities may be viewed as those in which there is consensus among participants. We would look then for nondominated alternatives: an alternative is nondominated if there is no other alternative which has bigger expected utility for every feasible combination of utilities and probabilities. Typically, this set will consist of several alternatives. If they are not too different, as judged by small differences in expected utilities for all agents, one basically may implement any of them. If this is not the case, one needs to appeal to tools suggesting what additional information is required to reduce the imprecision about what alternative to implement, e.g. based on distances as in Ríos Insua (1990). We should then elicit such information, if possible, and repeat the process. If not, we should appeal to some ad hoc criteria such as the maximin, advising the group that this has been adopted. See **Danielsson et al.** for a relevant application in *e*-participation.

6.4 Arrow's Impossibility Theorem

Because of its relevance for the ensuing discussion, we shall refer to Arrow's impossibility theorem (Arrow, 1951). Essentially, we consider the case in which m individuals have individual preferences over a set of options expressed through rankings (ordinal preferences) or ratings (cardinal preferences), and we want to determine the group preference as a function of the above.

Arrow considered the case in which the individuals rank the alternatives, concluding that there is no way of combining individual rankings under the assumptions of independence of irrelevant alternatives, non dictatorship, individual's sovereignty, positive association of social and individual values and universality, when there are at least two individuals and at least three alternatives. The independence of irrelevant alternatives states that the group ranking between any two alternatives depends on the individual ranking between these two alternatives only, that is, for each pair of alternatives a and b, whether a is ranked by the group higher then b or vice versa, depends only on the way the individuals rank a and b. The non-dictatorship states that, given a pair of alternatives a and b, there is no individual such that whenever he prefers alternative a to b, the group will also prefer a to b, regardless of the other individual's rankings. The individual's sovereignty means that every possible group ranking should be achievable by some set of individual rankings, that is, for any pair of alternatives a and b, there is some set of individual rankings such that the group prefers a to b. Positive association, or monotonicity, means that an individual should not be able to hurt an option by ranking it higher, that is, if any individual modifies his ranking by promoting a certain option, a, then the group ranking should respond only by promoting a or not changing, but never by placing it lower than before. Universality means that a group ranking is specified for all possible individual rankings.

Arrow's theorem created a good deal of literature (see, e.g. Kelly (1978)), suggesting that there is no clear rational democratic way to promote group decisions; see **Nurmi** for additional information.

One way forward is based on Keeney (1976), who requires individuals to provide ratings (cardinal preferences). He essentially restates Arrow's axioms in terms of ratings rather than rankings, showing that there is actually a group utility function which is defined additively. Specifically, if in the set of axioms quoted above we change expressions "individual ranking" and "group ranking" by "individual rating" and "group rating", respectively, the group utilities for each objective that evaluates different consequences of the problem can be constructed in the form (1):

$$u^g(a,\theta) = \sum_{i=1}^{n} \lambda_i u^i(a,\theta),$$

where $\lambda_i \geq 0$ is the weighting factor of the i-th individual, and $\lambda_i > 0$ for at least two λ_i 's. Practically, this means that one can construct a group utility function, which would satisfy the above-mentioned axioms, using the additive form of group utility. According to Keeney (1976), one should first get agreement on the objectives and alternatives, which defines the decision. Then, fundamental objectives will usually imply an additive group utility. The main difference will arise from the weighting factors of participants. Tuning them up would yield the group utility function to satisfy the axioms. This process, however, invokes interpersonal comparisons of utilities, which can complicate the implementation of the model in any given case. A pragmatic way forward is gained through the observation that interpersonal comparisons are, indeed, often implicitly made in group decisions; see Keeney (1976) for more discussion on interpretation and assessment of the group utility function.

6.5 CDA and *e*-Democracy

We discuss now the relevance of various approaches specified in Section 6.2 for democracy and *e*-democracy. We shall first refer to their connection with various conceptions of democracy and discuss them in the light of Arrow's theorem. We then discuss specific issues in connection with *e*-democracy, in reference to scalability and ease of implementation.

The direct model of democracy (see **Arenilla**, and social choice theories; see **Nurmi)** will favour modes $\mathrm{GDM_{VOTE}}$ and $\mathrm{GDM_{SEU}}$. In turn, $\mathrm{GDM_{supraDM}}$ would favor a representative model of democracy (see **Arenilla)** in which an elected entity responsible for the decisions uses in its analysis the preferences of the members of society. It, thus, favors the design of mechanisms to extract valid input from the public. Most decision analysts have proposed group decision support based on $\mathrm{GDM_{FAC}}$ to guide public deliberations within the participatory model of democracy. $\mathrm{GDM_{FAC}}$ uses facilitated workshops or decision conferences in which the group discusses facts and values that should lead to a decision for the group. Disagreements are investigated using sensitivity analysis to focus the discussion on the differences of opinions that matter, aid participants to communicate and mutually understand their positions and build consensual understanding. This process can be supported with elements of the democratic discourse theories described, e.g. in **Lourenco and Costa**. $\mathrm{GDM_{FAC}}$ assumes that while there may be quite different perspectives represented among group individuals, they share a general common interest and they are willing to reach a consensus through deliberation. Finally, $\mathrm{GDM_{NEG}}$ allows for a softer facilitated social process in which individuals bring very different interests and perspectives. This mode uses negotiation analysis principles and democratic discourse theories in order to design valid participatory processes to support the public within the participatory model of democracy, see **Lavín and Ríos Insua.**

The many paradoxes and impossibilities stemming from Arrow's Theorem have over the years essentially led most decision analysts to doubt the efficacy of $\mathrm{GDM}_{\mathrm{VOTE}}$. Although one can define algorithms to move the numbers and votes around so that, ultimately, a group ranking is mathematically defined, if one examines the assumptions that underpin the algorithms, one may find inconsistencies or even nonsense. One way to alleviate the problems arising from Arrow's result is to obtain more information about the individual preferences. Thus, instead of asking each participant to order alternatives, $\mathrm{GDM}_{\mathrm{supraDM}}$ and $\mathrm{GDM}_{\mathrm{SEU}}$ procedures ask them for cardinal information about strengths of preferences. Additive and multiplicative multi-attribute preference models have been implemented in $\mathrm{GDM}_{\mathrm{supraDM}}$ and $\mathrm{GDM}_{\mathrm{SEU}}$, using the preference values of the group members as attributes to evaluate consequences. These models for aggregation of cardinal preferences require interpersonal comparison of the individuals' strengths of preferences which are the cause of inconsistencies when axiomatic aggregation procedures are used. When the aggregation procedure is determined by an authority, the trade-offs on the impact of a decision among the group members' values are made subjectively within the mind of the authority, defining valid interpersonal comparisons. Note that Nash (1950) solution is invariant with respect to positive affine scale transformation of the individuals' preferences, and, therefore, it does not require interpersonal comparisons. However, it requires determination of the individuals' disagreement values.

The $\mathrm{GDM}_{\mathrm{supraDM}}$ approach is more promising at first sight: all interpersonal comparisons are made within the mind of the supra decision maker, and it is the issue of defining valid interpersonal comparisons objectively that tends to cause the paradoxes and inconsistencies that lead to the problems with $\mathrm{GDM}_{\mathrm{VOTE}}$ and $\mathrm{GDM}_{\mathrm{SEU}}$. In some cases, the supra decision maker actually exists: there may be an arbiter, formally responsible for recommending a decision which balances all stakeholder perspectives. Also in circumstances in which a government agency has the legal responsibility and accountability for making the decision but does want to take into account the views of citizens and stakeholders, then the assumption of a supra decision maker may again become plausible: the supra decision maker is the agency. In these circumstances, we can imagine participation systems in which individual citizens interact with a decision model, leaving their personal preferences and beliefs for the agency to later draw together into an analysis that will drive their decision. However, in true democratic approaches to *e*-democracy, the problem of the non-existence of the supra decision maker still exists: it is fiction which creates a fatal flaw in this approach. He has to be constructed by agreement among the group, and this leads to a further group decision, arguably as hard as the first, and an infinite regress.

Models under $\mathrm{GDM}_{\mathrm{FAC}}$ involve evaluating consequences directly by the group without considering individual evaluations, and, therefore, no aggregation is necessary. Thus, it is the group that should reach a consensus in an interactive way to determinate the group values. Therefore, most decision analysts have looked to $\mathrm{GDM}_{\mathrm{FAC}}$, developing the use of facilitated workshops or decision conferences in which behavioural aggregation of individual perspectives is driven by sensitivity analysis (Dryzek and List, 2003; French, 2003; Phillips, 1984). Gregory et al.'s (2005) approach to public and stakeholder participation is largely driven by this viewpoint.

The modes GDM_{VOTE}, GDM_{SEU}, $GDM_{supraDM}$ and GDM_{FAC} essentially assume that the group *wants* to co-operate and reach a consensus. GDM_{NEG} recognises that individual citizens and stakeholders may be more self-serving and wish to negotiate a good endpoint for themselves. Variants of GDM_{NEG} can lean more about the algorithmic or more about the structuring of a softer facilitated social process which can be run in workshops. The latter leads to public participation processes, again, similar in many ways to those discussed by Gregory et al. (2005).

It is clear that naïve approaches to *e*-participation and *e*-democracy will favour mode GDM_{VOTE} and the more algorithmic versions of $GDM_{supraDM}$, GDM_{SEU} and GDM_{NEG}. It is easy to design web systems to implement algorithms: after all, that is what the web and computers do. Moreover, numerically, the algorithms will converge to a solution, whether or not it is one supported in some fundamental way by the preferences and beliefs that participants have input. Although academics and professional decision analysts may not find the underlying mathematics difficult, to the general public and most politicians, it will be far from transparent. We should, therefore, emphasise that the paradoxes and impossibility results that have led decision analysts to develop participatory processes based upon mode GDM_{FAC} and social processes based upon GDM_{NEG} also should lead us to the same conclusion in the design of *e*-participation and *e*-democracy systems.

We end up with implementability issues. First, we have the issue of scalability. The more algorithmic GDM_{SEU}, GDM_{VOTE} and $GDM_{supraDM}$ are suitably scalable provided that their entailed analysis and elicitation are undertaken with the aid of a system, but see above comments about their conceptual appropriateness. On the contrary, GDM_{FAC} and GDM_{NEG} were initially conceived for 5, 15, perhaps 50 participants not for thousands or even millions that one might expect in an *e*-participatory process. Moreover, there is the issue of capability; these modes were designed for participants with some analytical inclination. Note, however, that analytical sophistication should be only expected on the facilitators supporting the processes. The idea, therefore, would be to create a user-friendly facilitator. A third issue refers to time and will, as there is a clear underlying assumption that users should have time and will to participate in the process, something not so frequent in modern times; we shall go back to this issue in later chapters by discussing participation incentives and delegating participation to software agents. Finally the issues of communication and coordination should be considered. It is not clear how decision analyses should be communicated to the general public. Coordination is even more difficult because no approaches are available that would be appropriate for such potentially large groups.

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Chapter 7
Voting Theory

Hannu Nurmi

7.1 Introduction

Although it is true that voting is not a sufficient condition for democratic governance, it is certainly a necessary condition thereof. Indeed, along with bargaining, it belongs to the most important ways of reaching collectively binding decisions. Voting is resorted in a wide variety of contexts: political elections, decision making in multi-member bodies, electing best entries in song contests, determining the winners in figure-skating, issuing verdicts in juries, electing officers to various positions in public organizations, etc. Voting is sometimes used in purely informal and ad hoc settings, such as when a group of people is deciding how to spend an evening or a family is deciding on the name of a just- acquired pet. Perhaps as a consequence of the variety of contexts in which voting is resorted to, it comes in many different forms or procedures. The most common in informal contexts is plurality voting or one-person-one-vote procedure. It imposes minimal requirements on the voter: he/she (hereinafter she) should only indicate one alternative that she considers superior to others. Whatever other information she might be able to provide regarding her opinion of the alternatives is simply not used.

In 1770, Jean-Charles de Borda gave a presentation at the French Royal Academy of Sciences pointing out that the plurality voting system may lead to a choice of a highly implausible alternative, viz. one that would be defeated by all other contestants in a pairwise vote by a majority of voters (McLean and Urken, 1995). For this to happen, the voters would need to have preferences over all pairs of alternatives or a preference ranking over them.

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Borda's observation and the accompanying suggestion for a voting system – today known as the Borda Count – received a fair amount of attention in the pre-revolution France and in the immediate aftermath. Borda suggested that the winners should be elected on the basis of their positions in the voters' preference rankings. Each rank would give an alternative a fixed number of points so that the lowest rank would give a points, the next to lowest $(a + b)$ points, the next $(a + 2b)$ points, etc. The points given to each alternative would then be summed up to a (Borda) score and the alternative with the highest score declared the winner. The essential feature of the system that Borda called the method of marks is that the point difference between any two consecutive ranks is a constant b. This system is today known as the Borda Count. In practice, the values $a = 0$ and $b = 1$ are used. What Borda also showed was that this system can be implemented on the basis of pairwise votes: by summing the number of votes an alternative gets in each pairwise vote against other alternatives one gets the Borda score of the alternative.

Borda's contemporary Marquis de Condorcet became the first critic of Borda's proposal and an advocate of systems based on pairwise comparisons. Condorcet showed that the Borda Count may not elect a candidate that would defeat all other candidates in pairwise contests by a simple majority. Today such a candidate is called the Condorcet winner. The tension between two types of notions of winning was thereby created. One emphasizes the positions that alternatives occupy in voters' preference rankings: the higher on the average, the better. This view is called positional. The other, binary, view stresses pairwise victories of alternatives: the more alternatives are defeated by a given one, the better are the chances of the latter's becoming the overall winner. This tension between two notions of winning is still visible in the contemporary literature.

After the times of Borda and Condorcet, there was a period of more than half a century over which no significant contributions were made to the theory of voting. In the latter half of the nineteenth century two names should be mentioned. C.L. Dodgson, an Oxford mathematics tutor better known as Lewis Carroll, wrote several pamphlets on voting systems inter alia apparently re-inventing the Borda Count (see Black, 1958). The second name from roughly the same period is E.J. Nanson. He invented a multi-stage elimination method for reconciling the positional and pairwise winning notions (Nanson, 1882).

Nanson's contribution was followed by yet another period of more than half a century over which no major contributions were made to the theory of voting procedures. The "third wave" of the theory began with the work of Black and Arrow in the late 1940s and early 1950s (Black, 1948; Arrow, 1951). This wave is still in full swing. The aim of this article is to provide an overview of the theory of voting: why it is important, how the problems are addressed and what are the main results. The next section gives a motivation for the study of voting. Section 7.3 deals with those properties of voting systems that we intuitively deem desirable. The next section reviews some important results on the compatibility relationships between these desiderata. We then focus on the "givens" of the theory and look at systems that require less of the voters than complete and transitive preference relations. Thereafter, we discuss briefly some systems that boil down to aggregating cardinal utilities of voters.

7.2 Motivation

Voting procedures are used in many contexts. We have procedures for electing presidents, parliaments and other assemblies. We also have procedures for deciding which legislative proposal is to be adopted, which verdict to issue in court cases, and so on. In some cases the outcome of voting – the winner – is a person to occupy an office. In others, the winners constitute a group of persons. The winner may also be a proposition or policy alternative. Given the variety of settings in which voting is resorted to it is not surprising that there are many voting procedures. What is perhaps more unexpected is that there are several procedures used for what appears to be an identical purpose, e.g. electing a president. Yet there are, and, what is more important, they are not equivalent. Indeed, the procedure is an equally important determinant of the voting outcome than the voter opinions. A hypothetical example illustrates this.

Suppose that there are three candidates, Brown, Jones and Smith, running for presidency. Suppose moreover that the electorate is divided into three groups. Group 1 supports Brown and views Smith as the second best. Group 2 supports Jones and regards Smith preferable to Brown. Group 3, in turn, regards Smith the best, Jones second best and Brown the worst of the candidates. Group 1 consists of 40%, group 2 of 35% and group 3 of 25% of voters. The voter opinions can be presented in the following tabular form.

Group 1 (40%):	Brown	Smith	Jones
Group 2 (35%):	Jones	Smith	Brown
Group 3 (25%):	Smith	Jones	Brown

If this is the distribution of opinions reported by the voters in the polls, the outcome is completely dependent on the procedure used. In particular, three often-used procedures lead to three different outcomes. To wit, the plurality voting elects Brown as this candidate is ranked first by the largest number of voters. Jones, in turn, would win in plurality runoff (or instant runoff) election since as no candidate is ranked first by more than 50% of the voters, Brown and Jones would make it to the second round, where Jones beats Brown with the aid of the votes of Smith's supporters. Most pairwise comparison methods would, in turn, end up with Smith since Smith, beats both Brown and Jones in pairwise contests by a majority of votes. Smith is thus the Condorcet winner.

So, three commonly used procedures end up with three different outcomes in this electorate. In fact, then, any candidate can be rendered the winner by varying the procedure. Is there a way of telling which procedure is "best"? This requires a study of the requirements that we impose on a good voting system and on the extent to which various procedures satisfy those requirements.

7.3 Procedure Desiderata

In the above example, the three voting procedures lead to different choices. Nonetheless these three can be seen as generalizations of a common intuitive notion of winning, viz. whichever candidate or alternative is ranked first by an absolute majority, i.e. more than 50%, of voters should be elected. Obviously, should this kind of opinion distribution or preference profile be encountered, all three procedures would end up with the same winner. A candidate ranked first by an absolute majority of voters is called the strong Condorcet winner. The requirement that eventual strong Condorcet winners should always be elected can be called the strong Condorcet winner criterion. It is satisfied by a large class of voting procedures. Not by all, though. Consider the following 13-voter profile over 3 candidates A, B and C:

8 voters:	A	B	C
5 voters:	B	C	A

Obviously A is now the strong Condorcet winner and would thus be elected by the above three voting procedures. Assume, however, that each voter is allowed to vote for two candidates and that the winner is the candidate receiving more votes than any other candidate. This system would elect B in this example. So would the approval voting which is a system that allows the voters to vote for as many candidates they like so that each voter can give each candidate either one or zero votes (Brams and Fishburn, 1983). The winner is the candidate that has more votes ("approvals") than the others. If we assume that the 8 voters approve both A and B and the 5 voters either B or B and C, the winner is B. The same outcome ensues from the Borda Count. It can be seen that the two notions of winning advocated by Condorcet, on the one hand, and Borda, on the other, are indeed quite incompatible. Even in highly consensual societies these two requirements may come up with different outcomes. Fatal criticism for both the Borda Count and approval voting, one might think.

This is not necessarily a correct conclusion, however. Although a strong Condorcet winner is quite robust with regard to eliminating alternatives, it is not robust at all with respect to adding or subtracting voters with opinions that intuitively should make no difference to the outcomes (Saari, 1995). To illustrate, consider again the above 13-person voting body and assume that it is expanded by adding 15 voters with the following opinions of the three candidates A, B and C:

5 voters:	A	C	B
5 voters:	B	A	C
5 voters:	C	B	A

Obviously, this additional group of 15 voters is quite incapable of making any difference at all between the three candidates unless some voters' opinions are given more weight than the others'. So, this group should – intuitively speaking – have no impact on the outcome of voting. But it does if the pairwise winners determine the outcome. It turns out that after the expansion of the voting body into a 28-member one, A is no longer the Condorcet winner; now B is. This kind of "instability" casts a shadow over the Condorcet winning criterion. At the same time, it should be pointed out that the Borda Count winners are vulnerable to changes in the candidate set: if a candidate is removed, the Borda Count winner may change (Fishburn, 1974). Indeed, the ranking determined by the Borda scores may be completely reversed upon adding or subtracting candidates.

Certain kinds of stability are, indeed, often regarded as a desirable property of voting rules. The voting outcomes should remain invariant under specific changes in the voting situation. For example, in democratic voting rules, one typically expects that the order in which ballots are cast or re-naming of the voters should make no difference in the voting outcomes. It is the distribution of opinions, not who has a given opinion, that should determine the outcome. This, often implicitly assumed voting system desideratum, is called anonymity. A similar requirement states that a re-labelling of the decision alternatives – e.g. re-naming the candidates – should make no difference to the content of the voting outcomes. After the re-naming, the same alternatives should emerge as winners, albeit carrying new labels. This requirement is known as neutrality: the procedures should treat alternatives in a neutral way. Despite their self-evident nature, the requirements of anonymity and neutrality are not always satisfied even in settings that are generally deemed democratic. In many voting bodies, the vote of the chairperson has a special significance when the opinions of the members are evenly distributed, i.e. when there is a tie. In those special circumstances, the chairperson's vote is often used as the tie-breaker. Thus, the system is not anonymous. Similarly, in legislative settings, the status quo alternative often has a special status. In the widely used amendment system, the legislative proposals and amendments are voted upon in pairs so that the winner of each pair confronts the next proposal according to a specific agenda. Of k proposals, $k-1$ pairwise votes are taken, and the winner of the last one is the overall winner. In this system, the agenda plays a crucial role in determining the outcome. To illustrate, consider again the preceding 15-voter profile over alternatives A, B and C. Suppose that the agenda of pairwise comparisons is: 1. A vs. B, and 2. the winner vs. C. Call this agenda I. If each voter votes according to her preferences in both ballots, the winner is C. Now, if the agenda were: 1. B vs. C, and 2. the winner vs. A, the winner would be A under the same assumptions. Let us call the latter agenda II. Thus, the agenda is decisive under what is called sincere voting, i.e. if all voters reveal their true preferences at each stage of the voting process.

The agenda-dependence of the outcomes does not, however, hinge on the sincere voting assumption. Suppose, instead, that the voters are sophisticated in the sense of resorting to backwards induction in determining their choices at each stage (McKelvey and Niemi, 1978). This means that under agenda I the voters first determine who to vote in stage 2. At that stage, C is confronted with either A or B, depending on the outcome of stage 1. Since stage 2 is the last one, the voters can be assumed to vote according to their preferences. Hence, if it is A that faces C in stage 2, the winner is C, while if it is B that is compared with C, the winner is B. Thus, in effect the choice that the (sophisticated) voters are faced with in stage 1 is between B and C, even though the agenda says that A and B are being compared. Since the majority prefers B to C, the outcome is B under sophisticated voting. Consider now agenda II. By the same argument, the winner under sophisticated voting is C.

The agenda-dependence of the amendment system makes it non-neutral. In legislative settings it is typically the status quo that confronts whichever alternative survives the preceding stages of the agenda. Under sincere voting, it thus has a favourable position with respect to other alternatives. Under sophisticated voting, in turn, it seems to have a disadvantage. In any event, the conclusion is that the amendment procedure does not treat alternatives in a neutral fashion.

Another type of stability requirement pertains to the very rationale of voting, viz. the idea that by voting one affects outcomes in a 'natural' way. Expressing support for an alternative should increase or at least not decrease its probability of being chosen. More precisely this requirement can be stated in two non-equivalent ways (Campbell and Kelly, 2002; Nurmi, 1999). (i) Given a preference profile, it should never be harmful for an alternative if some voters rank it higher than in the profile, ceteris paribus. (ii) Given a preference profile, it should never benefit a voter to abstain, i.e. the outcome resulting from abstaining should never be better in the voter's opinion than the one resulting from her voting according to her preferences. Requirement (i) is known as monotonicity and requirement (ii) as invulnerability to the no-show paradox or participation axiom. The former is an intra-profile property, that is, it considers a given profile of, say, n voters and k alternatives. The latter, in turn, is an inter-profile requirement: it considers two profiles with different numbers of voters. Yet, they are pretty close to each other. Monotonicity deals with choice sets resulting from the voters' changing their mind with respect to an alternative vis-à-vis the others, while requirement (ii) considers changes in voting outcomes resulting from eliminating preference rankings from the profile. Despite their intuitive appeal, they are violated by some commonly used voting systems.

Consider the following profile:

47 voters:	A	B	C
2 voters:	A	B	C
25 voters:	B	C	A
26 voters:	C	B	A

Suppose that the plurality runoff system or instant runoff (IRV) is being used. Obviously, A and C will get to the second round, while B is eliminated. In the second round, C defeats A by 51 votes to 49. Subtract now the 47 voters mentioned first (nearly a half of the electorate) and conduct a new election for the remaining profile. Now B and C make it to the second round, where B wins. Obviously, the outcome is better from the abstainers' point of view in the reduced profile than in the original one. Hence the plurality runoff system fails on the participation axiom or, in other words, is vulnerable to the no-show paradox, i.e. not voting may lead to a better outcome than voting.

The single transferable vote (STV) system is also vulnerable to the no-show paradox. This can be seen from the same example, since with three alternatives the plurality runoff system and STV are equivalent: eliminating the alternative with the smallest number of first place votes is tantamount to qualifying the two most vote-getters to the second round.

The non-monotonicity of IRV and STV is shown in the following example:

35 voters:	A	B	C
33 voters:	B	C	A
32 voters:	C	A	B

Here the second-round contestants are A and B, whereupon A wins. Suppose now that any number between 2 and 14 of those voters with the preference ranking B C A would rank A first other opinions remaining as above. Then the runoff contestants would be between A and C with C winning the overall contest. Hence additional support turns the winner (A) into a non-winner.

In the interpretation adopted above, monotonicity requires that additional support, other things being equal, does not render winners into non-winners. In the mechanism design literature one encounters another related concept, viz. that of Maskin monotonicity (Maskin, 1985). It states that if an alternative X is a winner in a profile P, and if a profile Q is constructed so that X's position remains the same or improves with respect to all other alternatives, then X is the winner in Q as well. Note that no other-things-being-equal condition is imposed on other alternatives vis-à-vis each other. In other words, the positions of other alternatives with respect to each other may change. Maskin monotonicity requires that no matter what changes occur with the relative positions of the other alternatives, as long as X is the winner and X's position is improved or remains the same with respect to them, it remains the winner. It turns out that Maskin monotonicity is a very strong desideratum: none of the voting systems discussed above satisfies it.

In some voting systems one may encounter a strong version of the no-show paradox. To wit, it may happen that a group of voters with identical preferences may succeed in getting their favourite (i.e. first-ranked) alternative elected by abstaining, while some lower-ranked alternative would win if they vote according to their preferences (Felsenthal, 2001, Personal communications). To illustrate the paradox consider the following 19-person profile and Nanson's method (Nurmi, 2005, 34):

6 voters:	C	A	D	B
5 voters:	A	B	D	C
5 voters:	B	C	D	A
1 voter:	C	B	A	D
2 voters:	C	B	D	A

Nanson's method ends up with B in this profile. If the last mentioned 2 voters abstain, the choice is C, their favourite.

Monotonicity and invulnerability to the no-show paradox are by no means the only stability desiderata imposed on voting systems. An intra-profile criterion known as consistency requires that coinciding choices made by sub-electorates be preserved in the choices made by the electorate at large. More precisely, for a system to be consistent, the following has to hold for any two mutually excusive and jointly exhaustive subsets of voters: if using the same procedure the subsets end up with at least partially overlapping choices, then those alternatives chosen by both subgroups are also chosen by the electorate at large, i.e. by the union of those subgroups.

This intuitively plausible desideratum turns out to be relatively uncommon among voting systems. For example, the plurality runoff system is inconsistent as shown in the following example. The electorate consists of two profiles one of which is as follows:

3 voters:	A	B	C
3 voters:	B	C	A
2 voters:	C	A	B

The other is:

3 voters:	A	C	B
2 voters:	C	B	A

In both profiles, A is elected by the plurality runoff, IRV and STV. However, in the combined 13-voter profile the winner is C no matter which of these systems is resorted to.

In contradistinction to these three (and many other) systems, the plurality voting, Borda Count as well as approval voting are all consistent. The same is obviously true of vote-for-two or, in general, vote-for-*k* systems in which each voter is to vote for a fixed number of alternatives and the winner is the one with a larger vote sum than any other alternative. Consistency of these systems offsets at least to some extent the fact that they all fail on the Condorcet winning criterion, i.e. they all may fail to elect a Condorcet winner.

A somewhat less common stability condition is called the Chernoff or alpha property (Chernoff, 1954). It states that if an alternative is the winner in a set of alternatives, it should be the winner in every proper subset of those alternatives it belongs to, other things being equal. Despite its intuitive appeal, this condition is very uncommon among known voting systems. In fact, of those discussed in the preceding only the approval voting satisfies it under the assumption that other things being equal means that not only the preferences of voters but also their approved alternatives remain the same in each subset considered. In other words, approval voting satisfies Chernoff property if we assume that for each voter and each subset of alternatives, the alternatives approved of by the voter are the same regardless of how many and what other alternatives are in the subset.

In addition to desiderata pertaining to stability of voting outcomes under various modifications of profiles or alternative sets, there is a property that captures the intuitive notion that under sufficiently large modifications of the preferences, the choice sets should change as well. More specifically, if all voters turn their preferences upside down, i.e. for each pair of alternatives they reverse their opinion, then the outcome of voting should change as well. We say that a procedure exhibits reversal bias, if there is a preference profile so that when every voter switches her preference between each pair of alternatives, the voting outcome remains the same as before the change. It is easy to construct examples of profiles where both plurality voting and the plurality runoff and, hence, IRV exhibit reversal bias (see Nurmi, 2005; Saari and Barney, 2003).

The desiderata of voting systems are many and, we have only touched upon a small subset of them (see Fishburn, 1977; Nurmi, 1987; Richelson, 1979; Smith, 2000; Straffin, 1980). Rather than defining voting systems and desirable criteria, a more efficient approach to search for good ways to aggregate opinions is to look at the compatibility of various desiderata. In the following section, we shall review some of the most important results in this direction.

7.4 Some Important Results

By far, the best-known result in the theory of social choice is Arrow's theorem. It is not only important substantially, i.e. saying what says about social choice but also methodologically. Arrow (1951/1963) sets the stage for a host of results similar in spirit in showing that certain sets of voting system desiderata are unachievable because the properties included in those sets are mutually incompatible. Arrow's theorem deals with social welfare functions which are mappings from Cartesian products of individual preference relations into similar collective preference relations. By similar, we mean that both preference relations are binary, complete and transitive over the set of alternatives. Arrow, thus, assumes neither more nor less than individual preference rankings. In addition to this formal requirement, the following four conditions are imposed on social welfare functions: (i) universal domain, (ii) independence of irrelevant alternatives (IIA), (iii) Pareto condition and (iv) non-dictatorship. The theorem says that these four conditions together with the formal requirement that both individual and collective preference relations be complete and transitive are incompatible. Obviously, the significance and practical importance of the result depends on how important and plausible the conditions are deemed.

Condition (i) states that the function should make no restrictions with respect to allowable individual preference rankings. This sounds like a reasonable or, at least, procedurally useful condition. On the other hand, it implies that the likelihood of condition violations plays no role in the theorem: systems which fail on some criterion under very specific and unlikely circumstances are on par with those where one can expect a criterion violation all the time. Condition (ii) is perhaps the most controversial of all. It states that the collective preference order between any two alternatives, say *x* and *y*, depends on the individual preference between these two alternatives only. In other words, whether *x* is collectively preferred to *y* or vice versa or both, depends only on the way the individuals rank *x* and *y*. Condition (iii) says that if each individual strictly prefers *x* to *y*, then *y* is not preferred to *x* in the collective preference relation. Finally, condition (iv) excludes dictators by saying that there is no individual whose preference relation over all each pair of alternatives coincides with the collective preference relation with respect to this pair.

All systems discussed in this article fail on condition (ii), viz. IIA. Consider, for example, plurality voting and the first example in our second section. The collective ranking resulting from plurality system is: Brown Jones Smith. So, the ranking between Brown and Jones is such that the former is preferred to the latter. Now, consider the subset consisting of Brown and Jones. In this subset, Jones is preferred to Brown. Hence, IIA is violated.

There are systems that fail on several Arrow conditions. One such system is the amendment procedure. It is well known that it may result in a collective preference cycle: x preferred to y, y preferred to z and z preferred to x etc. It thus violates the condition that the social preference relation be transitive. But it also fails on condition (iii). Consider the following profile.

1 voter:	A	B	D	C
1 voter:	B	D	C	A
1 voter:	D	C	A	B

With sincere voting and agenda 1. B vs. D, 2. the winner vs. A and 3. The winner vs. C, C wins. Yet, D is preferred to C by each voter. Thus, the amendment system fails on Pareto criterion.

Nearly equally celebrated as Arrow's is the theorem independently proven by Gibbard (1973) and Satterthwaite (1975). It deals with voting strategies and single-valued social choice functions. The latter are functions mapping all alternative sets and preference profiles into singleton sets of alternatives. These functions are also known as social decision functions. They, thus, specify for each alternative set and preference profile a single alternative, the winner. Voting strategy, in turn, indicates the preference ranking a voter reports when voting. This may be identical with her preference ranking over alternatives, but it may also differ from it. In the latter case, the voter is said to misrepresent her preferences. It is plausible to assume that a voter misrepresents her preferences if the outcome resulting from misrepresentation, ceteris paribus, is preferred by the voter to the outcome resulting from her sincere voting, again ceteris paribus.

Now, a voting system is manipulable in a voting situation, i.e. in a set of alternatives and a preference profile over those alternatives, if in that situation there is at least one voter who achieves a better outcome (from her own point of view) by misrepresenting her preferences than by voting sincerely. A voting system, in turn, is defined to be manipulable if there is at least one situation in which the system is manipulable. In other words, a voting system is manipulable if the sincere voting strategies by all voters do not always lead to a Nash equilibrium (Nash, 1951).

The Gibbard-Satterthwaite theorem says that every anonymous, neutral and non-trivial social decision function is either manipulable or dictatorial. A social decision function is non-trivial if for each alternative one can construct a preference profile so that this alternative will be chosen by the system.

Prima facie, the Gibbard-Satterthwaite theorem is quite dramatic; manipulability or dictatorship do not look attractive alternatives to choose from.[1] On closer inspection it is evident, however, that this is not a doomsday message for democratic institutions. Manipulability, i.e. gaining benefit from preference misrepresentation, may materialize in very rare situations only. Moreover, to benefit from preference misrepresentation the voter may need to know basically everything about the preference profile, i.e. each voter's preference ranking, which may be a tall order in most voting bodies. Finally, the theorem deals with singleton-valued choice functions, while most voting systems may result in a tie between two or more alternatives. These remarks are not intended to play down the importance of the theorem as a theoretical result. It is certainly of great significance in pointing out that the behavioural assumptions underlying voting behaviour should be taken into account in voting system evaluations. Results, such as those cited in the preceding, on properties of voting systems that hold under sincere voting assumption may fail under sophisticated voting assumptions.

The Gibbard-Satterthwaite theorem amounts to the incompatibility of non-dictatorship and non-manipulability among single-valued choice functions. Slightly later, Gärdenfors (1976) proved a theorem that deals with (possibly multiple valued) choice functions or social choice correspondences. He showed that all anonymous and neutral social choice functions that satisfy the Condorcet winner criterion are manipulable. Since the Condorcet winner criterion is often regarded as a highly desirable property, this result is of the same negative type as Arrow's. The Gärdenfors theorem leaves open the manipulability of those systems that may fail to elect the Condorcet winner when one exists. Yet, it is fairly straightforward to show that all those systems discussed above are manipulable. To show that the plurality runoff, IRV and STV are manipulable, consider the following profile of 8 voters:

3 voters:	A	B	C
3 voters:	B	C	A
2 voters:	C	A	B

[1] This is an exclusive "or" we are dealing with here since obviously dictatorial decision functions are not manipulable: the dictator can only lose by misrepresentation and the strategies of other voters are irrelevant for the outcome.

With sincere voting, there is a runoff between A and B, whereupon A wins. This is the least preferred alternative of the three voters in the middle of the profile. If one, two or all of them had voted as if their preference ranking is C B A, ceteris paribus, C would have won on the first round or after a second round against A. In any event, the outcome would have been better for the voters deviating from their true preferences in their voting strategies. The same profile can also be used in showing that the plurality voting system is manipulable. With sincere voting, the outcome is a tie between A and B. This can be broken in A's favour by one of the two last mentioned voters if she votes as if her first ranked alternative is A. Hence, this voter can bring about a preferable outcome by preference misrepresentation. The same profile can be used to show that sincere voting strategies do not lead to a Nash equilibrium under Borda Count, either. If all voters reveal their true preferences, the outcome is B, the lowest-ranked alternative for the two voters in the profile. If these voters rank A first, ceteris paribus, the outcome is A, their second-ranked alternative in their true preference ranking.

A special kind of preference misrepresentation occurs when a group of voters abstains from voting. If by so doing the outcome is preferable to the group than the one that had ensued had it voted in accordance with its preferences, we have an instance of the no-show paradox. The paradox is, of course, an unpleasant surprise not only for its "victims", i.e. people who would have been better off by abstaining than by voting but also to the advocates of democratic forms of decision making. It undermines the very rationale of those forms. Moulin's (1988) theorem, which states that the Condorcet winner criterion and invulnerability to the no-show paradox are incompatible, is bad news for those who deem the criterion of utmost importance. It is worth observing that the theorem does not say anything at all about systems that do not satisfy the Condorcet winner criterion. Among those, there are systems that are invulnerable to the no-show paradox and those that are not. In the first group, there are systems such as plurality voting, vote-for-*k* and the Borda Count, in the latter plurality runoff, IRV and STV.

There is a stronger version of the no-show paradox which occurs when, by abstaining, a group of voters helps to bring about the election of their first-ranked alternative, while by participating, ceteris paribus, they would contribute to the election of some other, i.e. lower-ranked, alternative. Moulin's result leaves open the possibility that invulnerability to this stronger version would not be incompatible with the Condorcet winner criterion. These hopes are largely squashed by a theorem (Pérez, 2001) which states that, when they exist, nearly all systems that elect a Condorcet winner can exhibit the strong version of the no-show paradox. Note again, however, that this theorem does not extend to systems that fail on the Condorcet winner criterion. The plurality runoff system appears to be invulnerable to the strong version of the paradox. By abstaining, a group of voters may, if anything, block the entry of their favourite to the second round but not increase its chances of being elected. Similarly, in STV and IRV the abstainers increase the likelihood of their favourite being eliminated.

The above is but a small and biased sample of various incompatibility results pertaining to voting systems. To counterbalance them there are several important results on compatibility of various desiderata. Perhaps the best-known of these is May's (1952) characterization of the majority rule as the only rule defined over two alternatives that satisfies

1.1 anonymity,
1.2 neutrality,
1.3 duality and
1.4 strict monotonicity.

Of these conditions 1.1 and 1.2 have been touched upon above. 1.3 says that if each voter reverses her preference over the two alternatives, then the outcome is also reversed. 1.4 states that, if there is a tie, only one individual's preference change is needed to break it to the direction of the preference change. May's result thus states that the conditions 1.1–1.4 characterize the simple majority rule and, conversely, any rule that satisfies these conditions is equivalent to the simple majority rule.

Some other voting systems have also been axiomatized. One of them is Borda Count. Young (1974) shows that the Borda Count is the only system that satisfies

2.1 neutrality,
2.2 consistency,
2.3 faithfulness and
2.4 cancellation property.

Faithfulness is the very natural requirement that the system be such that if the collective body consists of only one individual, then the winner according to the system coincides with her first-ranked alternative. The cancellation property, in turn, is satisfied by systems which, in a situation where for each pair of alternatives x and y the number of voters preferring x to y is equal to the number of voters preferring y to x, result in a tie between all alternatives.

Approval voting has been given an axiomatic characterization also (Fishburn, 1978). There are three axioms in this system: neutrality, consistency and disjoint equality. The last-mentioned is the requirement that if two individuals come up with two distinct choices A and B from the same set of alternatives, then when forming a collective body of the two individuals, its choice set coincides with the union of A and B.

The theory of social choice has thus both good and bad news for the designer of voting institutions. Summarizing, the bad news is that no system satisfies all conceivable desiderata, not even the most important ones. Positional methods, such as plurality voting and Borda Count, tend to perform poorly in terms of the Condorcet winner criterion, while doing very well in terms of consistency and monotonicity. The systems based on pairwise comparisons of alternatives, in turn, do in general well in terms of the Condorcet winner criterion, but are typically inconsistent and vulnerable to the no-show paradox, most even to the strong version of it. Multi-stage systems, such as plurality runoff, IRV, Nanson and STV, are in general non-monotonic and inconsistent.

7.5 Systems Requiring Minimal Information

The theory of voting systems is an applied field within social choice theory. As such, it is largely based on Arrovian assumptions about the form in which individual opinions are expressed: the individuals are endowed with complete and transitive preference relations over the alternatives. However, most of the voting systems used in practice do not require voters to have anywhere nearly such structured preferences. In many systems the voter simply places a check or cross next to the candidate she votes for or writes down the number corresponding to the candidate or party. It is true that STV and IRV are based on the expectation that the voters reveal more about their opinions than simply one candidate, alternative or party, but these systems are used in relatively few large-scale elections. More often than not, singling out one alternative is what the voters are expected to do. So, how does this practical limitation go together with the theoretical assumption of complete and transitive preferences?

In principle, there is no inconsistency in assuming that the voters have preference rankings over all alternatives and devising a system that only accepts one alternative from each voter. Indeed, in the above examples of plurality voting we have throughout assumed that people have preference rankings over all alternatives but typically vote for just their top-ranked one or – in case of strategic voting – some other alternative. The point is that the voter is assumed to have a dichotomous classification of alternatives – the best vs. the others – instead of a preference ranking. If this would be the case, then most of the negative results would go away since the crux in achieving them is that the voters be able to provide a ranking, i.e. an opinion of preference regarding also those alternatives they do not cast their vote for. For example, to find out about monotonicity violations one has to know how the voters rank not only those alternatives they vote for, but also at least some of those they do not vote for. The same argument goes for the vulnerability to the no-show paradox.

Another related issue is the impact of the existing voting system on the structure of preferences of voters. It makes sense to argue that if the system works with dichotomous preferences, the voters tend to think in a dichotomous manner about the alternatives. Why bother with preference rankings as long as the system allows you to tell the best one apart from the others only? If we are dealing with dichotomous preferences rather than preference rankings, the available voting system repertoire becomes more restricted: systems like the Borda Count, STV or IRV are not applicable. As pointed out above, many of the negative results are also thereby avoided. But is it really plausible to assume that the voters can only classify candidates into two groups: good and less than good ones?

If this assumption is made, then a natural social choice assumption to start from is that, instead of complete and transitive preference relations over the alternatives, the voters are endowed with individual choice functions. Consequently, the task of a voting system designer is to look at the properties of various choice function aggregation rules. Considerably fewer pages have been written on choice function aggregation than on preference ranking aggregation. One of the magna opera in this field is Aizerman and Aleskerov's (1995) study. For our purposes, the main message of the book is negative: substituting individual choice functions for individual preference rankings seems to lead to analogous – albeit not identical – incompatibility results as in the mainstream literature. To illustrate, consider the following (plausibility) conditions on collective choices based on individual choice functions[2]: (i) citizen sovereignty: for any alternative x, there exists a set of individual choice function values so that x will be elected, (ii) choice-set monotonicity: if x is elected under some profile of individual choices, then x should also be elected if more individuals include x in their individual choices, (iii) neutrality, (iv) anonymity and (v) choice-set Pareto: if all individuals include x in their individual choice sets, then the aggregation rule includes x as well, and if no voter includes y in their individual choice set, then y is not included in the collective choice.

In social welfare functions the aim is to impose the same formal properties on the aggregation rule as on the individual opinions: completeness and transitivity of preference relations. Surely some conditions have to be imposed on choice set aggregation rules to distinguish reasonable from unreasonable ones. Consider Chernoff's condition.[3] Recall that it states the following: if an alternative is among the winners in a set of alternatives, it should also be among the winners in every subset it belongs to. Another similar property is concordance. Suppose that the winners in two subsets of alternatives have some common alternatives. Then, the rule is concordant if these common alternatives are also among the winners in the union of both subsets. The properties of Chernoff and concordance can be associated with both individual and collective choice functions. In social welfare function, the same formal properties are imposed on both individual and collective preference relations. We can make the same requirement for choice-set aggregation rules, i.e. insist that Chernoff and concordance be satisfied by both functions.

Using Aizerman and Aleskerov's example we can show that two quite natural looking aggregation rules fail on either one of these two requirements. Rule 1 is a version of the majority rule: whenever an alternative is included in the choice sets of a majority of voters, it will be elected. Rule 2 is plurality: whichever alternative is included in more numerous choice sets than the other alternatives is elected. The former rule is called local since the inclusion of an alternative in the collective choice set can be determined independently of other alternatives ("locally"). Rule 2, on the other hand, is not local as the determination of whether x belongs to the collective choice set requires comparison with all other alternatives ("globally"). Suppose we have alternatives x, y and z, three individuals and the individual choices as indicated in the following table.

Clearly concordance is not satisfied by rule 1, since x belongs to the choice sets from $\{x,y\}$ and $\{x,z\}$ but is not included in the choice set from $\{x,y,z\}$. On the other hand, rule 2 fails on Chernoff condition, since $\{z\}$ is included in the choice set from

[2] The conditions are those of Aizerman and Aleskerov (1995, 236), but I have taken the liberty of naming them.

[3] Aizerman and Aleskerov call this the heritage condition.

alt. set	ind.	Choice	Sets	Rule 1	Rule 2
	ind. 1	ind. 2	ind. 3		
$\{x,y,z\}$	$\{x\}$	$\{z\}$	$\{y\}$	Empty	$\{x,y,z\}$
$\{x,y\}$	$\{x\}$	$\{x\}$	$\{y\}$	$\{x\}$	$\{x\}$
$\{x,z\}$	$\{x\}$	$\{z\}$	$\{x\}$	$\{x\}$	$\{x\}$
$\{y,z\}$	$\{y\}$	{z}	$\{y\}$	$\{y\}$	$\{y\}$

$\{x,y,z\}$ but not to one from $\{x,z\}$. It is also worth noticing that plurality does not satisfy choice-set monotonicity, while majority does.

The results of Aizerman and Aleskerov are largely negative as far as local aggregation functions are concerned: they typically fail on some rationality conditions. Much less is known about non-local aggregation operators.

7.6 Systems Based on Richer Information

Individual choice functions can be regarded as less demanding for the voters than ordinal preference rankings over alternatives. However, we often encounter situations where we in fact have much more preference information about alternatives than just their ranking. Typical examples are situations where the individual's opinions are reflected in her willingness to pay for various alternatives. Since monetary sums are ratio scale variables, the individual is able to signal her preferences in a much richer way than in the standard social choice setting.

A relatively recent proposal for a voting system that utilizes richer than ordinal ranking information has recently been made by Balinski and Laraki (2007). The authors call it majority judgement. The procedure is the following. Given a set of alternatives or candidates, the voters evaluate each of them by assigning them a value from a set of values, such as integers from 0 to 10 or from the set {excellent, very good, good, satisfactory, tolerable, poor, to be rejected} or from {A, . . . F}. The highest grade given by an absolute majority of voters is called the majority grade of the alternative. This is a well-defined concept when the values in the set can be ordered from best to worst. For each alternative, there is a value so that more than 50% of the voters give it or higher value to the alternative in question. Now, the majority judgement winner is the alternative with the highest majority grade. If the voters are listed according to the grades they give to a candidate from the lowest to the highest, the majority grade is the one given by the median voter, i.e. the voter with as many other voters on her "lower" and "higher" side. In case the median is not unique, the majority grade is the lowest of the values defining the median interval of grades. Ties between candidates are broken in the following manner. For each candidate with the same majority grade, say "good", one tallies the number of voters who give the candidate a higher grade than "good". Let them be b in number. Similarly, one counts the number of voters who give the candidate a grade worse than "good". Say their number is w. If $b > w$, one gives the candidate the majority grade "good+".

If $b < w$, then the majority grade is “good-”. This may help in breaking some ties, but it is still possible that more than one candidate gets the same majority grade, say “good+”. In this case, the tie is broken by observing the number of voters who give the candidate a grade higher than “good”. The candidate for whom this number is higher wins the tie. In a similar vein, for ties involving candidates with “good-” grade, one counts the number of voters with grade lower than “good” assigned to the candidate. The candidate for whom this number is smaller wins the tie.

Balinski and Laraki argue that majority judgement encourages voters to reveal their true valuations of candidates. This is debatable, however. Suppose that the voters have cast their grades to all candidates and that there is a tie for winner between candidates A and B, both of whom get the majority grade “good+”. This means that exactly the same number of voters regard both A and B better than “good”. Consider now a voter who grades A as “excellent” and B as “very good”. If this voter knew the distribution of grades, it would make sense for her to grade B as “tolerable” or something else below “good”. Thereby she would break the tie, ceteris paribus, in favour of her favourite A. This shows that in the majority judgement system the sincere revelation of grades does not always lead to a Nash equilibrium. Hence the system is manipulable.

A related system, called utilitarian voting, has been proposed by Hillinger (2004, 2005).[4] It is basically identical with range voting (Smith, 2000). The underlying idea is that for each candidate the voters vote by expressing their cardinal utility values for that candidate. The winner is the candidate with the largest sum of expressed utilities. The first crucial feature of utilitarian voting is that each voter is allowed to assign any grade or score to any alternative, i.e. the score given to candidate A in no way restricts the score that can be given to candidate B. The second feature is that the scores lie on a predetermined scale of values, say (0,1) as in approval voting. This feature is shared by nearly all voting systems. The third defining characteristic of utilitarian voting is that the winner or, as the case may be, the order of priority among candidates is determined by the sum of scores received from the voters. The candidate with the largest score sum wins.

Obviously the voter input in utilitarian voting is very similar to the one resorted to in majority judgement. The method for determining the winner, however, differs. The utilitarian voting elects the candidate with the largest average score, while the majority judgement ends up with one associated with the highest median grade. As we just saw, the majoritarian judgement is manipulable. The same example can be used to show that utilitarian voting is manipulable as well. In fact, manipulating these systems is not much different from manipulating the Borda Count. If one knows the toughest contestant of one’s favourite, then giving the former the lowest possible grade – regardless of one’s true valuation – helps in electing one’s favourite. Moreover, in those cases where one’s favourite does not get the highest

[4] For earlier systems based on group utilities, see Bacharach (1975), Keeney (1976) and Keeney and Kirkwood (1975).

possible grade in one's true evaluation, giving it the maximum grade will increase its likelihood of being elected.

The main point is, however, that alternatives to systems that operate on individual preference rankings exist and deserve scholarly attention. Strategic behaviour in opinion revelation cannot be excluded, but this is a problem in aggregating ordinal preference information as well.

7.7 How to Evaluate Systems?

Given the abundance of voting systems and performance criteria as well as the theoretical results on compatibilities between various desiderata, it is worth stopping for a moment to consider: what use can we make out of all this information in the design of voting systems? The most straightforward way to proceed is to use a single criterion of performance to eliminate all those systems failing on this criterion, then possibly pick another criterion to eliminate some of the remaining ones etc. Of course, the criteria used have to be deemed the most important ones. Candidates for this type of elimination criteria are absolute majority or strong Condorcet criterion (if an alternative is ranked first by more than half of the electorate, this alternative has to be elected), the Condorcet winner criterion, monotonicity, consistency, the Condorcet loser criterion (if a candidate would be defeated by all the others in pairwise majority comparisons, it ought not to be elected), Pareto criterion, etc.

There are problems with this type of approach. To wit, which are the most important criteria? The scholarly community is divided on this issue. Even if unanimity prevailed as the most important criteria, this approach would lead to a dichotomy in each criterion: those systems that satisfy the criterion and those which do not. Both classes are bound to consist of many systems.

Within each class one could resort to probability or simulation modelling to find out the theoretical probability or frequency of criterion violations under various "cultures", i.e. assumptions concerning the distribution of preferences in the electorates (Gehrlein, 2006). But which culture is most appropriate for this kind of assessment? The early simulations of voting procedures as well as analytical probability models were based on the "impartial culture" assumption according to which the preference ranking for each voter is generated randomly and independently of other voters. It has turned out that this assumption may lead to flawed conclusions about the frequency of various anomalies in voting systems (Regenwetter et al., 2006).[5]

Alternatively, one could utilize multiple performance criteria simultaneously and construct a dominance relation over voting systems. A system dominates another if it satisfies all the criteria – among those considered – that the latter satisfies and at

[5] This does not make impartial culture simulations worthless. On the contrary they are very useful is assessing the purely procedure-related effects such as how close the winner intuitions of various systems are to each other.

least one criterion that the latter does not satisfy. Once this relation has been constructed, it is natural to make the final choice from among nondominated systems. This approach to system choice is not without problems, either. The set of nondominated systems is typically pretty large one vis-à-vis the original set of systems. Moreover, dominance implicitly treats all criteria equally, i.e. they are all deemed of equal importance.

Historically, the choice of the best voting system has been deemed as context-dependent. What has been found right in electing the president has typically not been viewed appropriate in judgement aggregation. Perhaps this is how it should be. Some choice settings emphasize the consensual nature of the outcomes, while in others intensive support of large voter groups seems like a plausible desideratum. In both types of settings a wide variety of systems is available.

The property of manipulability or strategic misrepresentation of opinions is a kind of meta-criterion since it has implications to other system properties. If the system is manipulable and has a set of desirable properties when the sincere opinion revelation assumption is made, it is not guaranteed that those desirable properties should also hold when the voters resort to strategic behaviour. Strictly speaking what manipulability entails is that there is a situation where a voter can benefit from misrepresenting her opinion. One such situation is enough to classify a system manipulable. So, a more refined analysis would call for estimates regarding the relative frequency of such situations. In practice, the manipulability of a system depends on, at least, three different aspects (Nurmi, 2002, 110–111):

1. The empirical frequency of those profiles in which an individual or group can benefit from opinion misrepresentation.
2. The nature of information that the voters need in order to misrepresent their opinions with success.
3. The payoff difference that a successful misrepresentation brings about to the voters engaged in it.

Therefore, instead of manipulability as a dichotomous notion one should talk about degrees of manipulability if these three aspects are anything to go by. Kelly's (1993) measure of degree of manipulability focuses precisely on the first aspect by defining the degree of manipulability as the number of profiles in which the procedure is manipulable. This measure can be modified by weighting the profiles by the number of voters who can benefit from misrepresentation (Smith, 1999). Nonetheless, one ends up with a measure that is relative to the number of voters and alternatives.

The second aspect is of great practical importance, since the manipulability of a system in principle means very little in practice if the information that the voters need to benefit from opinion misrepresentation is of the kind that they cannot typically possess. On intuitive grounds, one could argue that plurality voting requires no more information about other voters' views than the distribution of the first ranked alternatives, while STV requires a lot more detailed information in order for the misrepresentation to succeed. The third aspects relates directly to the incentives of the voters to misrepresent their opinions: the larger the benefit, the more likely is misrepresentation, ceteris paribus.

As was stated above, the manipulability of a system means that sincere voting strategies do not always lead to Nash equilibrium outcomes. But what does it mean that a voting outcome is not an equilibrium? By definition it means that at least some voters may regret their voting strategies in the sense that *assuming that the others stick to their strategies* they could have brought about a better outcome for themselves had they selected some other voting strategy. But what is there to justify the assumption that the others would not change their behaviour? Very little. The notion of equilibrium is based on a counterfactual proposition. This is perhaps worth taking into account in assessing the practical implications of manipulability results.

7.8 Searching for Consensus

Often voting systems are resorted to in an effort to reach a consensus on an issue where several alternative positions are available. The task is trivial when all voters have an identical position on the issue at hand. But, in general, no such unanimity exists, but has to be found using some procedure. Given a non-unanimous profile of opinions, a plausible way to proceed is to look for the collective opinion that is closest to the expressed opinions of voters. If all but one voter in a large group have an identical preference ranking and the collective choice is to be a ranking as well, the collective ranking closest to the observed one would seem to be the one representing the vast majority opinion. In large bodies the same suggestion would hold when all but very few voters have an identical opinion.

Although pretty obvious in these cases, the search for the nearest collective ranking in general needs some explication. There are many ways of measuring the proximity of two preference rankings. Perhaps the best-known is the inversion metric which tallies the number of individual binary preference inversions needed to transform one ranking into the other. Kemeny's rule is based on this metric (Kemeny, 1959). For any given profile of complete and transitive preference orders over k alternatives it determines the closest collective preference ranking by computing for each possible $k!$ ranking its distance (in the sense of the inversion metric) to each individual's ranking and summing these. The collective ranking for which this sum is at the minimum is the Kemeny ranking and its first-ranked alternative the Kemeny winner.[6] Kemeny's rule can, thus, be seen as a method that defines a consensus state and a metric for measuring distances from observed profiles to ranking candidates and that, moreover, results in a ranking for which the sum of distances in at the minimum.

[6] Young (1988) argues that this method is in fact the one that Condorcet had in mind in late eighteenth century. Young (1995) shows that Kemeny's method can be seen as resulting in the maximum likelihood ranking.

In Kemeny's rule, the consensus pertains to every rank in the profile. In many settings the consensus on every position in the collective ranking is something of a luxury. Especially, if the task is elect just one alternative, it makes little sense to search for such a comprehensive consensus. Instead one could look for the collective ranking which is closest to the observed individual rankings and which differs from the individual rankings only in positioning the same alternative first in the ranking. In other words, the collective ranking would be obtained by counting the number of inversions needed to put a given alternative first in every individual ranking and summing those inversions over voters. The winner is then the alternative that needs the smallest number of inversions to end up first in every voter's ranking. Nitzan (1981) shows that the ranking resulting from this minimization is the same as the Borda ranking, i.e. the order based on Borda scores of alternatives.

It turns out that all ranking-based voting systems can be characterized in terms of a goal (consensus) state and a metric used in measuring the distance between the observed preference ranking and the goal state (Meskanen and Nurmi, 2006). For example, the plurality voting can be defined as the rule which minimizes the distance between the observed profile and a state where all voters have the same alternative ranked first keeping the rankings between the other alternatives intact. Since the goal is the same as in the Borda Count, the metric must be different from the inversion one. Otherwise we would be dealing with the Borda Count. Indeed, the metric for plurality voting is defined so that whenever two rankings differ in terms of the first ranked alternative, their distance is equal to unity. Otherwise, it is zero.

The goal state cum distance metric characterization opens a new angle to analysing voting systems. It is the decision setting that often determines the most appropriate goal state. Thereafter, the metric captures our views of closeness of different opinions. As these two aspects pin down a voting system, a way to choose the best voting system for any given purpose is to spell out one's intuitions in terms of them, i.e. state explicitly what is the desired goals state and how one measures distances between various views.

7.9 Conclusion

The theory of voting is approached above from three perspectives: (1) by determining which desirable or undesirable properties various systems possess, (2) by studying the mutual compatibility or incompatibility of those properties, and (3) by characterizing them in terms of various conditions or goal state-metric combinations. The first approach takes its motivation from the fact that the institutional (voting system) design does not take place in a vacuum, but in the setting where historical and cultural features dictate the set of realistic systems within which the choice has to be made. Hence it is important to know the properties – desirable and undesirable – of the systems deemed realistic. While informative and potentially useful, this approach is on par with classification of objects in the theory of measurement, i.e. necessary but only the first step in the way of measuring properties. The second approach is more advanced in abstracting away concrete voting systems and dealing with the relationships that obtain between their properties. This approach is notorious for its primarily negative results showing the incompatibility of various desiderata of systems. The third approach is either "axiomatic" in the sense of aiming at a characterization of systems with the aid of properties necessary and sufficient for them or distance-based in the sense of determining the underlying goal states and distance metric for each voting system.

Most results in the theory of voting have been achieved under the standard assumption that the voters possess complete and transitive preference relations over the alternatives and that we are looking for optimal ways of aggregating those preferences either into a set of best alternatives or a collective preference ranking. Since many incompatibility results depend on these assumptions, it is worthwhile to look for plausible alternatives for them. The standard assumption can be either too demanding – the voters do not necessarily have preference rankings over all alternatives – or too modest – the voters may have a more refined opinion about the alternatives than a mere ranking. Both of these possibilities have been briefly discussed above. It seems that the emphasis on voting system studies has recently moved towards aggregating more detailed voter input than preference rankings.

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Chapter 8
Real-World Decision Aiding: A Case in Participatory Water Management

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8.1 Introduction

Decision-making is becoming increasingly complex in many sectors. This is due to overlapping legislative requirements, multiple decision-makers and managers, competing interests, unequally distributed resources and social and environmental impacts, as well as uncertainties about the future in a more connected and rapidly changing world. This is certainly the situation for water management in many regions of the world, where decision-makers are faced with increasing levels of uncertainty, complexity, and conflict. In such contexts, the decision-making process over the selection and implementation of water management strategies becomes a major challenge. In order to ensure the sustainable development of water resources and their dependent societies and environments, there is an increasingly recognized need for the development of improved approaches to aid inter-organizational or multi-stakeholder decision-making in the water sector.

In this chapter, we first outline the challenges real-world complexity presents in the water sector, followed by an introduction to the concept of decision-aiding and its relevance to participatory, inter-organizational water management. Decision-aiding models that could be used in this context are then outlined, in particular a participatory structure design and a decision-aiding process model. We then present a real case in Australia, where a theoretical model underlay elements of the participatory workshop series used in the creation of the Lower Hawkesbury Estuary Management Plan in New South Wales. We thus highlight the usefulness of decision-aiding models to drive the success of participatory water management planning. Challenges encountered are discussed, including the case when multiple analysts and decision-makers must collectively design a decision-aiding process.

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8.2 Participation in the Real World

To introduce our example case of decision-aiding in the real world, we will first highlight the typical complexities encountered in the participatory water management domain. We then briefly introduce some of the existing theory and practice of aiding decision-making in inter-organizational contexts, as well as the levels of participation of different organizations or stakeholders who take part in decision-aiding processes.

8.2.1 Complexities in Water Management

Water management faces many challenges to overcome as the complexity and inter-relatedness of problems increases. Socially based water management disputes commonly result from differences in stakeholders' values and viewpoints, interests on how water should be used, and power struggles over scarce water resources. Highly value-charged debates are often sparked over questions of whether water is equitably distributed between people and geographical areas or is of sufficient quality for human and environmental needs. Since the 1970s, protests and social activism over water management projects, such as dam construction, have become more widespread (Hutton and Connors, 1999). Local issues can now quickly create international level protests thanks to rapid information transfers enabled via new technologies such as the Internet and global media networks. Human rights issues were, for example, the focus of international protests over the displacement of the estimated 1.3–1.9 million people for the Three Gorges Dam on China's Yangtze River (Gleick et al., 2006). The growing interconnectedness of world systems means that almost all local human activities can have global impacts. This may be by economic processes, such as trade, or via societal changes at physical, cultural, environmental or individual human levels, which include changing beliefs, values, views, relations, and practices.

Nowadays, water management typically requires representatives at multiple levels of governance to decide how water should or can be used and shared between a variety of stakeholders and the environment under conditions of major uncertainty. Such uncertainties and areas of potentially rapid change include climatic conditions and natural hazards such as floods, droughts, volcanic eruptions, disease outbreaks, earthquakes, tsunamis and cyclones; technology and scientific innovation; political regimes and priorities; the economic climate; and human behaviour and cultural imperatives. A major challenge is to aid water management in this increasingly populated, globalized, environmentally degraded and inequitable world with unprecedented levels of complexity, uncertainty, and conflict.

This challenge is made more difficult due to the fact that water management processes are highly distributed activities occurring at a multitude of spatial, temporal, and institutional scales. Each local area around the world has a variety of different water-related issues in need of management, and at each larger scale there are numerous planning and management groups responsible for overseeing the coherence of these local efforts to ensure that more sustainable overall directions are pursued at their own level. This has resulted in many layers of water management practices which are all interrelated and attempt to deal with different stakeholder groups and their issues, needs, values, interests, representations, resources, and actions in dynamic, complex situations; often with limited success.

In light of this increasing water management complexity, we consider that one of the most pressing needs is to *develop and implement adapted methods of aiding inter-organizational decision-making processes for improved water management*.

8.2.2 Aiding Inter-organizational Decision-Making

Decision-aiding in the inter-organizational context focuses on providing a *decision analyst* or analysis steering group with methodological aids that allow facilitation of a group of representatives from a range of organizations or stakeholder groups to structure and exchange views. These exchanges may span focal areas ranging from problem formulation and objective identification to final recommendations or *choices*. This process can be considered to occur in an *interaction space* (Ostanello and Tsoukiàs, 1993) or a *collaborative space* (Digenti, 1999), where the collective construction of the participants' representations of the problem can be regarded as a *model*, *meta-object* (Tsoukiàs, 2007) or *intermediary object* (Vinck and Jeantet, 1995), which can form the basis for further collective discussion and decision-making. Interactions between the various process participants are governed by rules that may only exist within the *interaction space*. Related to this description, Mazri (2007) defines an *interaction space* as *a formal or informal structure that is governed by a number of rules and is aimed at providing a field of interaction to a finite set of actors.*

In inter-organizational groups with representatives participating in the interaction space, there are certain context specificities which need to be considered by analysts developing decision-aiding approaches. For example, unlike in groups that share the same organizational background and accountability structures, there will be outside factors, interests or rules which will affect the ability of each participant to agree on decisions. Participants may only have limited power to enter into commitments on behalf of their organizations, making such a working group *multi-accountable*, unlike a traditional *team-like* group (Friend, 1993). In this context, we consider that the *interaction space* of the decision processes will not be limited to just a working group which meets, but rather expanded to include the external interactions and negotiations that are likely to occur in and between each participating organization at different managerial and government administration levels. This expanded interaction space for inter-organizational, *multi-accountable* groups is represented in Fig. 8.1. Unlike the central interaction space, it may not have easily identifiable finite bounds.

We stress that our definition of *organization* in inter-organizational groups is taken in the broadest possible manner; as a group, association, business, institution, government or any ensemble of two or more people who share at least one common

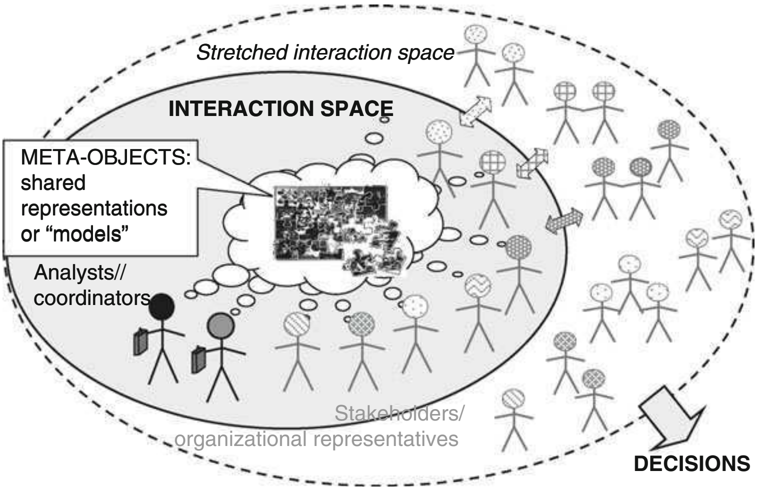

Fig. 8.1 Decision-aiding for multi-accountable groups in a stretched interaction space

characteristic, interest, vision or goal. In Fig. 8.1, representatives from the same organization are represented with the same shading. Double-headed arrows represent interactions that may occur outside the central interaction space and that have an impact on the shared representations produced.

The decision-aiding processes used for multi-accountable groups must be applicable to these more complex environments. In particular, where those participating with the analyst in the central interaction space rely upon others from the stretched interaction space to make the final decisions, Alexander's (1993) theory of *interorganizational coordination* considers a similar setup where the participants working in the central interaction space are labeled as an *inter-organizational group* and the whole stretched interaction space, including the central zone, constitutes the *inter-organizational network*. We further consider that analysts in our interaction space use a variety of methods to marshal the different skills and knowledge required for working with a diverse group of organizational representatives to create their common representations. This analyst-led coordination process is represented by the *coordination structures* outlined in Alexander's (1993) framework.

In such complex organizational situations, Akkermans (2001) suggests that in traditional organizational theory from the management sciences, focusing on command and centralized hierarchical control is of limited value for analysts involved in the coordination of decision-aiding processes, because of the lack of a formal single locus of authority. Rather, the networks' decisions and collective actions are driven by the power and influence of the individual representatives and their supporting organizations, through means such as communication, persuasion, and consensus building.

In this section, we have so far concentrated on outlining the structure in which inter-organizational decision-aiding can occur. We also want to understand what dynamics may take place in an inter-organizational decision-making process. On this topic, Ostanello and Tsoukiàs (1993) provide a descriptive model of such a process, which outlines a number of characteristic *states*, based on the ideas of MacKenzie's (1986) *process laws*, that could be observed in the evolution of the interaction space. In this model, the process state is defined in terms of the participating *actors*; *objects* (the concerns or stakes of the actors); *resources* that the actors are willing to commit to their objects of interest; and the *relations* between these elements (Ostanello and Tsoukiàs, 1993). Such a model, even if simplified to just a few theoretically important variables, can provide a useful basis for understanding inter-organizational decision dynamics and therefore provides a conceptual framework for the development of a decision-aiding approach to guide the evolution of the interaction space in a favourable direction.

8.2.3 Levels of Participation

We now turn our attention to the question of what *levels* of participation these organizational representatives may have in the central interaction space. To explain what we mean by levels of participation in a decision-making process, we give the following examples, to which we hope most readers will be able to relate. A woman comes home from work and to her husband:

(1) announces that they are to go out together to dinner tonight
(2) announces that she wants to go out to dinner and asks what he thinks about the idea
(3) asks her husband whether he prefers going out for dinner or to the theatre
(4) asks what they should do tonight

In other words, the person asking the questions can choose how much to include someone else in a decision-making process. In our inter-organizational situation, it will typically be the coordinators or analysts who, in interaction with the decision maker(s), attempt to define the participation levels which best suit each stakeholder. This should occur according to their expectations and potential to contribute to creating the best possible *common* representation. Mirroring the levels in our anecdote, Mazri (2007) proposes a four-step classification for decision-aiding processes for risk management where Level 0 is *information*; Level 1 is *invited response to information*; Level 2 is *consultation*; and Level 3 is *implication in decision-making*. These levels are placed on a grid for purposes of an analyst's choice of participation for each potential organizational representative, based on his or her adequacy of resources and stakes for treating different objects of debate in a decision-aiding process. The concept of *adequacy* of these stakes and resources relates to the level of relevance or correspondence of these actors' attributes to the object of debate requiring a decision. For example, an actor having a high adequacy of resources to understand an object of debate, but is unlikely to be impacted by the decision (few stakes in it), could just be consulted (Level 2) to obtain those knowledge resources. This grid is represented in Fig. 8.2. The idea of *objects of debate* will be further discussed in this chapter.

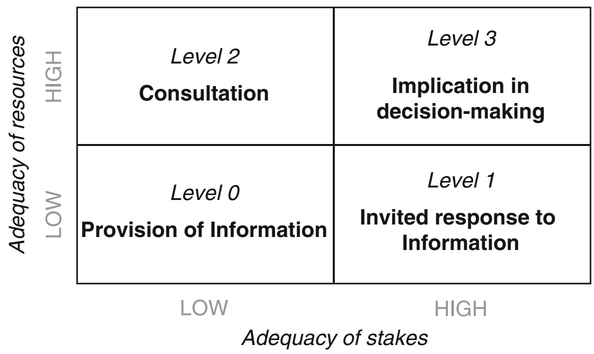

Fig. 8.2 Defining levels of participation in decision-making processes

This classification system of participation levels is but one of many. However, it is differentiated from a number of the traditional power-based or empowerment-based classifications, due to consideration of both the *stakes* and *resources* dimensions. Most power-based classifications were developed in an attempt to give citizens more control over government-run decision-making processes that affect them (e.g., Arnstein's (1969) ladder of public participation or Mostert's (2003a, b) classifications for water planning and management). Empowerment-based classifications were developed in a slightly different light to promote maximized enlightened collective action and social learning (e.g. Rocha, 1997, or Cornwall, 1996). We see Mazri's (2007) classification as a useful platform to start our consideration of the design of theoretically based decision-aiding processes, although we also stress that many later choices of specific methods used in the interaction space to promote the creation of common representations could also be oriented to enhance social learning or multi-organizational collective action and empowerment. It is also important to consider here that this classification should not be used as a rigid guideline free of the decision-context. Rather, it should be used as a soft model that helps decision makers and analysts to define the best participatory structure considering the context (including its constraints) and stakeholders specificities (Mazri, 2007). More precisely, the distinction between low and high levels of resources or stakes is largely subjective and should reflect the openness of the decision maker(s) to dialogue. We also note that decision makers can easily increase some of the stakeholders' knowledge resources by providing training sessions related to the issues in need of decisions.

We conclude this discussion with two remarks:

1. Participatory decision structures are chosen to be such. It is not always the case that it is convenient to have carefully developed structures mapped to individual stakeholders since they can be expensive to develop, possibly ineffective and their outcomes potentially uncertain.
2. Establishing a participatory decision-making structure is itself often a participatory decision-making process, which occurs between the analyst and one or

more decision-makers and sometimes organizational representatives, see Bayley and French (2008) for further information.

8.3 Theoretical Models and Methods for Decision-Aiding

Theoretical models for decision-aiding have been studied in a number of disciplines, including operational research or management science, law, and psychotherapy (Brown, 1989; Capurso and Tsoukiàs, 2003; Tsoukiàs, 2008). In this section, we highlight two models from the field of operational research decision-aiding. We will start with a model of how to design a participatory process structure and move on to a model for eliciting process content from the participants. Currently available participatory methods designed to aid such elicitation will be briefly introduced, followed by a critique and methods for working with inter-organizational or multi-accountable groups.

8.3.1 Participatory Structure Model

Before thinking about potential methods and how to conduct a participatory decision-aiding process, we shall address some issues of decision-aiding process initiation and design. When commencing an inter-organizational decision-aiding exercise, it is likely that there will be some preliminary interaction between the *decision analyst* and one or more of the organizational representatives. During this preliminary interaction, an agreement may be made to help these organizations structure and manage a particular issue under certain rules of engagement (Avenier et al., 1999). Once an agreement has been created, a general process design, including the *participatory structure* under which the exchanges in the interaction space are to take place (Mazri, 2007), needs to be developed. In this process design phase, the decision analyst's capacity to engage the participants (Creighton, 2005) needs to be legitimated. Representatives from different organizations who are considered to have interests in certain objects of debate related to the problem situation can then be invited to participate in the decision-aiding process through the construction of the meta-objects or models, as denoted in Fig. 8.1. A model developed by Mazri (2007) for the design of participatory structures, stemming from the field of OR, is presented in Fig. 8.3.

Note first that this is not a model for the autocratic design of a participatory structure but rather a model for the participatory process of design of the participatory structure between the analyst, decision-maker, and potentially a number of other actors. The model starts with two steps to characterize the decision-maker and study a number of objects of debate. For the characterizations, *intrinsic* refers to basic elements that the decision-maker or actors use to build a worldview including *stakes* which may be *concerns or interests* in a wide range of contextual elements (i.e. social, environmental, economic) and *resources* belonging to the actor. These resources include *a set of knowledge bodies* (scientific, practical, contextual, etc.)

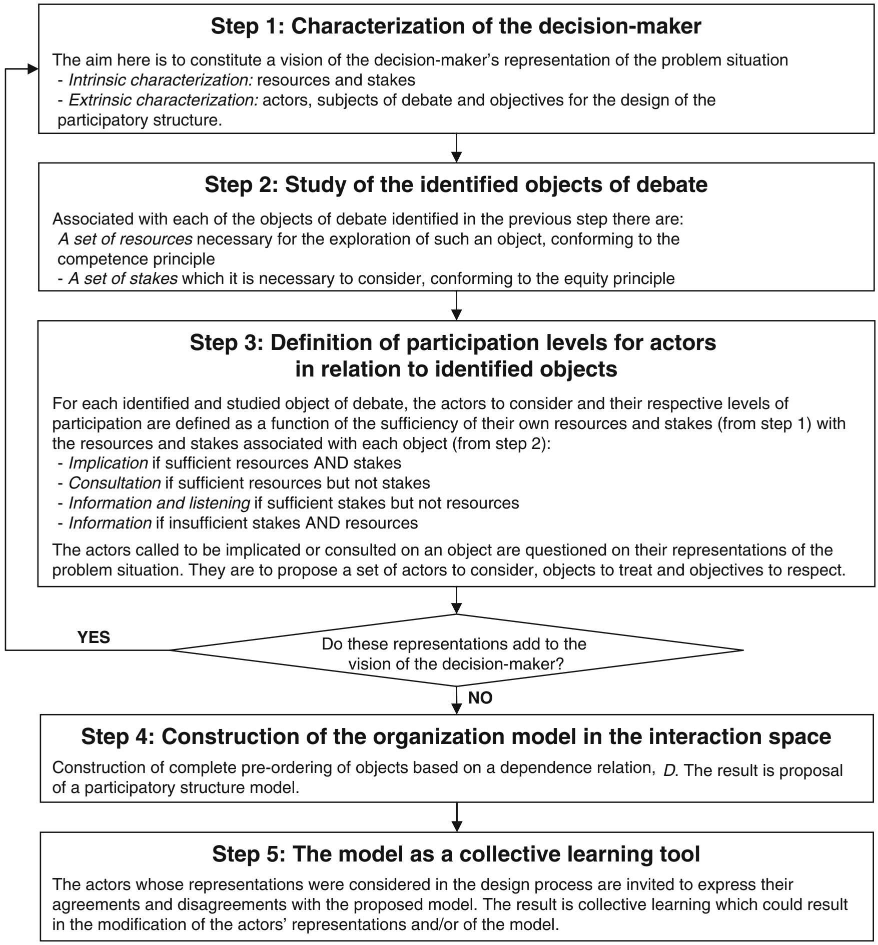

Fig. 8.3 Descriptive model of the participatory structure design process (Mazri, 2007)

that can be employed to understand and study the problem situation; *value systems* considered legitimate for the problem situation under study and that can be used to influence the outcomes of a participatory process; and *attributes that confer powers of influence* such as judicial attributes including legal responsibility, economic attributes, including financial resources, and social attributes including respect, charisma, and confidence (Mazri, 2007). *Extrinsic* characteristics are those elements which can be used to describe the representation of the problem situation in which the actor is evolving, in this case relative to the creation of a participatory structure: who is relevant to the problem context that the actor thinks should be involved in the creation of the participatory structure and why; what are the most critical elements of interest that should become objects of debate considered by future participants in a participatory process; and for which objectives, such as a legitimate decision-making forum, conflict resolution or advisory process, should the participatory structure be designed (Mazri, 2007).

Another point in Fig. 8.3 that requires further explanation is the definition of the principles of *competence* and *equity* referred to in Step 2. Firstly, the principle of *competence* of the actors stems from the work of Habermas (1984) where it is used to describe a set of possibilities and talents of an actor, which is also similar to the set of deliberative rules suggested by Webler (1995) and Mazri (2007). Similarly, the principle of equity is based on the work of Habermas (1984) and that reformulated by Webler (1995) and is to be assured when an *ideal speech situation* is maintained in which the set of participating actors have equal chances to formulate and explain their declarations; present and defend their positions relative to the four validity constraints of comprehensibility, truth in the scientific sense, normative rightness, and sincerity (truthfulness); contest validity claims of other participants; and influence the final modes of validation or decision-making rules and, hence, selection of final recommendations (Mazri, 2007; Webler, 1995).

The last point of note relates to the creation of the organizational model in Step 4, where the dependence relations between each two of identified objects of interest (for which levels of participation based on Fig. 8.2 are defined in Step 3) in the participatory structure are developed. Mazri (2007) defines three types of dependence relations between the objects: dependence (uni-directional relation); inter-dependence (bi-directional relation); and independence (no relation). From these dependencies, a logical series of objects to be treated in the participatory structure can be developed, similar to a work flow diagram where the critical path can be established to aid additional implementation planning.

Of particular interest in this formalized participatory structure model is the iterative nature of the process and the search for continual improvement and social learning as the process progresses. Mazri (2007) notes that there may also be other types of feedback in between different steps of the process, and not only around the represented loop, which would aid to encourage further reflexivity of, and social learning between, the actors. Validity of the model is based on adherence to the ideals of competence, equity, efficiency (the structure permits efficient use of resources) and legitimacy (the structure is accepted and legitimized in the context of decision-aiding that it has been designed for) (Mazri, 2007). From this participatory structure model, we now move on to outline a decision-aiding process model that could be used for examining each of its identified objects of debate.

8.3.2 Decision-Aiding Process Model

In operational research, decision-aiding (process) models do not just include guideline-type models but also models based on formal and abstract language. For example, the model of Tsoukiàs (2007) defines a number of cognitive artifacts which are to be generated through the phases of the decision process. Each cognitive artifact is composed of a number of sets of elements, which can be represented using set theory. The decision-aiding process model producing these artifacts is shown in

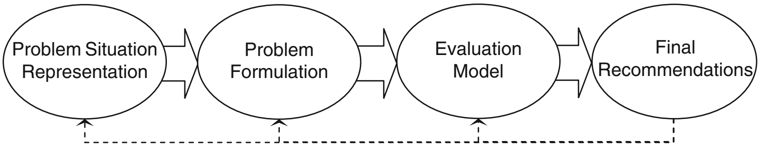

Fig. 8.4 Four-stage decision-aiding process model. Derived from: Tsoukiàs (2007)

Fig. 8.4. There may be iteration between the building of these cognitive artifacts and feedback to previous phases to update them, which is represented by the dotted lines in Fig. 8.4.

Following Tsoukiàs (2007), each of the phases or *meta-objects* outlined in the model can be characterized by a number of elements. These are to be elicited or developed through the process as follows:

- Problem Situation – definition of a set of actors (i.e. stakeholders, experts); a set of objects (i.e. concerns, interests or stakes of the actors); and a set of resources (i.e. factors linked to the actors and objects);
- Problem Formulation – definition of a problem statement (i.e. the area of a problem situation which requires decisions); a set of potential actions (that actors may take relative to the problem statements); and a set of points of view (that the actors may use to observe, evaluate and compare the actions);
- Evaluation Model – definition of a set of alternatives (i.e. action sets or scenarios) to be evaluated; a set of dimensions, attributes, or indicators and their corresponding scales under which the alternatives will be described and measured; a set of preference criteria for alternative evaluation; an uncertainty structure; and a set of operators which will allow the synthesis and manipulation of all of the above information to aid decision-making.
- Final Recommendation – definition of a chosen decision related to the problem statement with corresponding validity/legitimacy analyses (i.e. sensitivity or robustness analyses and process and content evaluations).

Using *formal* and *abstract* models as a basis for decision-aiding provides a number of benefits over other types of support such as guidelines in certain problem situations, including that these models can be used to reduce the ambiguity that is structured in human communication, and are generalized theoretical constructs which are independent of the decision-aiding context (Tsoukiàs, 2007).

8.3.3 Criticism and Extension

Although these two models aid our understanding of how a participatory structure and a decision-aiding process could be more effectively designed, both may require some innovation in order to be applied in the real-world inter-organizational context of the water sector described in the first section.

Firstly, Mazri's (2007) participatory structure model only considers that there is one decision-maker who compares his or her views to those of other actors in order to enrich his or her own views. Although this main decision-maker is common in the French administrative context of local planning and risk management (the *Préfet* has the ultimate decision authority), in other inter-organizational cases there is likely to be more than one ultimate decision-maker. For example, accepting transboundary water plans will likely require the decisions of a number of administrations, with some decision-makers being able to block others. In such a case, Mazri's model would likely have to be applied either numerous times with these different decision-makers to obtain their views on the participatory structure and then come to a compromise or else apply within the group with a common vision of a participatory structure being formed through dialogue.

A similar critique can be made of Tsoukiàs' (2007) model if is to be used in an inter-organizational context. The model was originally developed for a simple analyst–client relationship rather than for the intra- or inter-organizational context. The adaptations to the model required for it to be relevant to the inter-organizational context would include defining multiple problem statements. For example, one problem statement could stem from each of the actors associated with or having an interest in the decision-making process. This change would then have follow-on effects to the elicitation of other elements through the model, including that a set of final recommendations would also be required.

More generally speaking, the above models fail to appropriately consider the specificities of multi-accountable groups. There is empirical evidence (see Mingers and Rosenhead, 2004) that problem situations exist where a *multi-client* perspective can be taken. We mean this in the sense that the decision-aiding process refers to multiple actors who share power over decision-making, who do not necessarily share any cognitive artifacts that have been developed to improve the problem situation, and who require the presence of an analyst, often in the form of a facilitator. Moreover, to the concept of *analyst* we may associate a team of individuals who (partially) reflect the stakes within the interaction space and the interests of the different stakeholders.

Therefore, we may also extend the model based on the inter-organizational context outlined in Fig. 8.1 to further specify the set of actors into the following:

- a subset of *core participants*, who interact in the *interaction space*;
- a subset of *associated stakeholders*, who may be either directly related to the core participants through organizational or personal affiliation, or unrelated to the core participants and where their stake in the problem situation may be known or unknown to core participants; and
- a subset of *project team members*, such as the *analysts* who are responsible for facilitating, organizing and managing the decision-aiding process, including any required external analysis outside the interaction space. Members of this set may also either be *core participants* or *associated stakeholders* at any point in the decision-aiding process.

We consider that throughout the decision-aiding process a number of feedback loops or iterations between the four meta-objects (see Fig. 8.4) are likely to occur, in particular to allow formal or informal input from the *associated stakeholders* who will eventually have some authority over accepting and making decisions based on the final recommendations.

As these models are constituted of formal and abstract constructs, how exactly they are to be used must be determined by the analysts taking part in the design and implementation of the decision-aiding process. A decision-aiding process in an inter-organizational context and the use of the decision-aiding model are likely to be part of a larger planning and management process, the context of which must be taken into account by the analysts. Under these constraints there is then a need for method choice or design to obtain the formal elements of the model and use them in a coherent manner that can be tested for their validity and legitimacy (Landry et al., 1983; 1996).

In general, there may be a variety of possible methods that would be acceptable for allowing the process of modelling and exchanging views on certain elements of the meta-objects, but which ones are to be chosen or designed will likely have to be negotiated between the project team members (analysts, coordinators, and potentially some core participants or associated stakeholders).

A range of methods, such as mapping exercises, individual reflection, and collective discussion and analysis, may be used to elicit the set elements and relations between them within the problem situation, dependent on the context and the project team's capacities and preferences and the stakeholders' needs. Specific methods likely to be useful for inter-organizational settings include those from OR research and practice known as *problem structuring methods*, as outlined in **Carreras and Franco**.

Specific methods used in decision-aiding processes to respond to increasing complexity, including in the water sector, include participatory modelling, also known as *shared vision modelling* (Palmer et al., 1993), *group model building* (Vennix, 1996), or *mediated modelling* (van den Belt, 2004), where the analyst takes the role of the facilitator or modeller to attempt to understand and synthesize collective knowledge. Different types of models, including cognitive or causal maps, may be developed in the problem situation and formulation phases, and then simulation models or multi-criteria matrices may be used in the evaluation model stage. Some of these processes have the potential to move closer to being processes of *rationalization* in the sense of Habermas and his communicative action theory (Habermas, 1984). Such processes of co-construction theoretically occur in an *ideal speech situation* where the confrontation of different stakeholders' rationalities through deliberative discourse and interaction can occur as a means of coming to commonly legitimized decisions (Habermas, 1996). To what extent this model of communicative action can be validated in practice through these processes and how participatory modelling can be best organized as a collective decision-aiding process is still in need of investigation.

The problem of decision-aiding in the current and future world water sector therefore requires further research, especially on how decisions can be better aided. It is increasingly difficult to legitimate the use of some OR decision-aiding tools, such as optimization or hydrological models on a purely normative basis, as was traditionally possible in technocratic societies where the place of the *expert* was not challenged (Fischer, 1990). This is largely due to the realization that there are multiple human rationalities which are difficult to take into account in decision-aiding processes without adapted consultative or participatory methods. These processes would include stakeholder communities, encompassing citizens or the public, officials or decision-makers (policy makers and managers), and experts (Thomas, 2004). If the use of such OR tools or models can be constructively legitimized through such participatory modelling processes – in other words, the stakeholders take ownership of the problem, its formulation, the models developed and used, and the recommendations – such models may still prove valuable in the quest to manage and find sufficing and collectively legitimated solutions to complex water management challenges.

Considering this discussion we make the following claims that will be investigated through the case study presented in the next section:

(1) we need a decision-aiding methodology to improve inter-organizational decision-making for water management, as well as theoretical models and problem-structuring methods that can form a useful part of this methodology; and
(2) we need negotiation skills, amongst others, for putting the methodology in place in the real world.

8.4 Intervention Case: Regional Estuarine Management in Australia

The intervention case presented here describes the creation of the Lower Hawkesbury Estuary Management Plan (LHEMP). We first give some background to the context of estuarine management in Australia, before treating the specifics of the decision-aiding process.

The Lower Hawkesbury River and its estuary are located on the northern fringe of Sydney Metropolitan Area, separating Sydney from the Central Coast Region of New South Wales in Australia. The estuarine region has a warm temperate climate (Miller and van Senden, 2003) and contains a large percentage of bushland, much of which lies in National Parks adjacent to the waters and is currently protected from land development. The region has many areas of intense scenic beauty and harbours many important ecological, economic, cultural, and social values. The estuary supports a few small foreshore settlements which provide the oyster, prawn trawling, fishing, and tourism industries with necessary infrastructure and access to their activities. Most of the urban, industrial, and agricultural land uses are located further up the estuary's tributary creeks.

The region is currently attempting to cope with a number of important pressures including high population growth, estimated to be a 15% increase over the last 10 years to 2006, and holiday season population influxes; pollution from a variety of sources, including runoff from urban and agricultural areas, discharges from sewerage treatment plants (STPs), boat discharges, toxic substances found in boat anti-fouling paints, and slipway scrapings, construction, and dredging activities; pest, disease, and aquatic weed infestations and outbreaks; unnatural flow patterns, for example, due to STP inflows and water extraction; controlled burning and bushfires; and intensive recreational use (BMT WBM, 2008; Forrest and Howard, 2004; HNCMA, 2005; HSC, 2006b).

Recent major issues for estuarine management have included the 2004 outbreak of QX disease in the Sydney Rock Oyster population, causing high mortality rates and substantial economic losses (DPI, 2006); the outbreaks and growth of the aquatic weed, *Caulerpa Taxifolia,* since 2000 (Kimmerikong, 2005); toxic algal blooms which pose threats to a number of aquatic organisms, the oyster industry, and recreational water users; and contentious issues related to estuarine inflow qualities and quantities from STPs, on-site sewerage treatment systems and storm water runoff. Future management is likely to be impacted by similar issues and the effects exacerbated by climate change mechanisms (CSIRO, 2007).

Current estuarine management practice in the Lower Hawkesbury is subject to a large variety of policies and statutory controls. Policies created at the international level or at the Australian Government level are typically translated into State level policy and legislation. One of the main exceptions is the new *Water Act* 2007 which may be enforced at the Federal level. However, its relevance to the estuary is likely to be limited to complying with the new provisions related to the Bureau of Meteorology's access to water information. Therefore, the majority of estuarine management considerations fall under at least 12 relevant pieces of State Government legislation and a range of policies, including State Environmental Planning Policies (SEPPs), as well as falling under Local Government Development Control Plans (DCPs) and Local Environment Plans (LEPs). Other policies and plans that are relevant to this estuary's management include the Hawkesbury-Nepean Draft Catchment Action Plan 2006–2015 sets the direction for investment priorities. Further information on relevant legislation and policies applicable to the Lower Hawkesbury Estuary is available in BMT WBM (2008).

Related to the multiplicity of regulations, laws, and policies which have a bearing on estuary management, there are also a large number of actors responsible for ensuring compliance with these instruments, including several Local Governments, State Government Departments, and the Hawkesbury-Nepean Catchment Management Authority. Furthermore, other regional stakeholders and estuarine users such as industry groups, water agencies, recreational associations, and users also play a significant role in estuary management through their own actions or by their work in the local Estuary Management Committees which develop sub-regional estuary management plans in areas under Local Government control. However, the efficacy of overall management in the Lower Hawkesbury Estuary is thought to be currently limited due to policy fragmentation and a lack of coordination of management actions (Kimmerikong, 2005). The region is therefore in need of an integrated multi-institutional, multi-stakeholder agreed and adopted plan for action in order to ensure a more sustainable future for the socio-ecological estuarine system under current and new challenges.

In light of these challenges, the participatory decision-aiding process for the plan creation was largely driven by the Hornsby Shire Council, one of the local governments in the planning zone and supported by researchers and consultants. The participatory process stages, including three interactive workshops, were adapted to adhere to the Australian and New Zealand Standard for Risk Management (AS/NZS 4360:2004), and an external scientific and legislative review was carried out by consultants (BMT WBM and SJB Planning) in the project team. A range of stakeholders from state and local governments, the water and sanitation authority, local industries, community associations and residents took part in the process stages of *initial context establishment*, including the definition of estuarine values, issues, and current management practices; *risk assessment* based on the stakeholder defined values (assets) and issues (risks); and *strategy formulation* to treat the prioritized risks as input to the estuary management action (or *risk response*) plan. Further risk assessment of the actions defined from the strategy formulation and external review was completed by the consultants in collaboration with the local government representatives driving the process. The draft management plan (BMT WBM, 2008) was put out to public exhibition for further comments, and the final revised plan has been recently accepted by both local governments in the region approximately two and a half years after the commencement of the participatory process. For this chapter, we will concentrate our case definition section on how the decision-aiding process based on the Tsoukiàs (2007) model was initiated and the decision-aiding methodology collectively designed. In-depth information and evaluation of the implemented participatory process may be found in the workshop reports (Daniell, 2007b).

8.4.1 Decision-Aiding Case Definition

Having a legitimate role as an analyst or coordinator of a real-life inter-organizational decision-making process appears crucial to being able to introduce decision-aiding theory and methods into the process. This was a key concern of the first author (who we will call *the researcher* in this section) when trying to find an appropriate intervention case for her research on the operationalization of these models and methods. In the LHEMP process, the researcher's legitimization was first constructed through her inclusion in the public tender written by the Local Government's estuary manager to contract a project manager for the plan creation. The researcher's participatory process proposal, research project outline, and how she would offer her work services to the participatory process development were written into the tender. These inclusions followed on from a couple of discussions of mutual interests between the estuary manager and researcher, and a project proposal that the researcher had sent to the estuary manager prior to the tender writing. The process for the plan creation outlined in the tender (HSC, 2006a) was largely based on the methodology outlined in Daniell et al. (2006) and Daniell and Ferrand (2006) that had been based on the Tsoukiàs (2007) model and was to include a series of two–four stakeholder workshops and an external document review. During the tender process, one consultant out of the number who applied to manage the project rang the researcher before submitting his tender proposal to clarify, consult, and negotiate over the number, scope, and dates of the workshops to gain a preliminary agreement with the researcher on having three workshops. This consultant headed the consortium of private environmental engineers and planners that was finally selected through the public tender process to manage the project in collaboration with the estuary manager and the researcher.

During the project's initiation meeting of the estuary manager with the contracted project manager, researcher, and a number of their colleagues, the first proposed adaptation to the decision-aiding methodology underlying the participatory process was voiced. The estuary manager stated his interest in basing the process on the Australian Risk Management Standard AS/NZ4360:2004 (Standards Australia, 2004, 2006), something which had not been specifically outlined in the Tender. None of the project team members had previously used the Standard, and to their knowledge, it would be the first time that it had been proposed for use in such a broad scale, inter-organizational, and participatory process. Following analysis of the Standard, the researcher found that it appeared compatible with the Tsoukiàs (2007) decision-aiding process model and only minor adjustments to the proposed workshop series would be needed. She was therefore willing to support the estuary manager's proposal. The project manager also gave in-principal support, and the three workshops and external review activities of the project team were planned to follow the Standard's phases, as shown in Fig. 8.5.

Project meetings, telephone calls, and emails were used to define the participants, methods, agendas, and roles of the project team members in each of the workshops. With the researcher keeping an eye on the elements of the Tsoukiàs

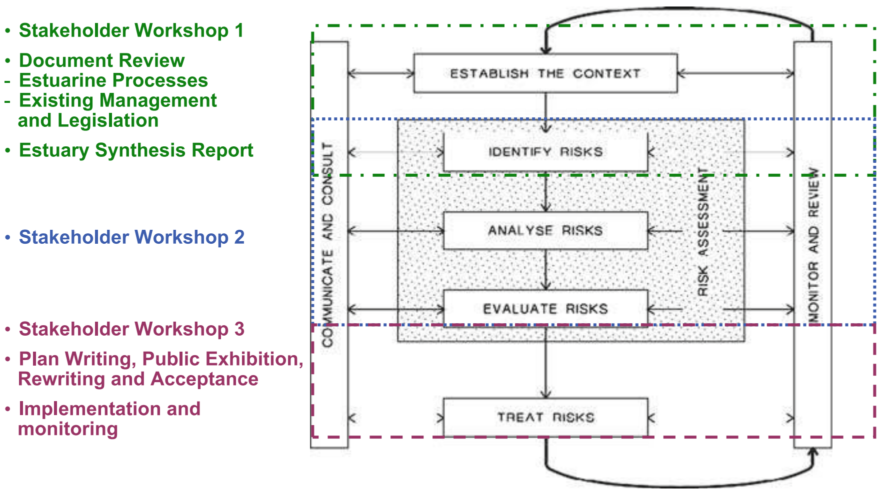

Fig. 8.5 LHEMP participatory risk management process (based on AS/NZS 4360:2004)

(2007) model she wanted to elicit from the participants, as well as her knowledge of problem-structuring methods and different types of evaluation models, she worked with the project manager (who also had a range of preferred methods from his previous experience in running workshops) and the estuary manager to design the methods.

This collective work ranged from collaborative to heavy negotiation and compromises on some aspects of the workshop process. For example, it was originally planned to have all stakeholders participating or *implicated*, according to Mazri's (2007) model, on all objects of debate in the workshops; yet prior to the second workshop heavy negotiation resulted in some of the community stakeholder members being excluded from this workshop and only given *information* on it afterwards. The researcher was mostly able to collectively design the methods used to meet her decision-aiding model needs or successfully negotiate their use. For example, she negotiated the use of an individual card brainstorming technique for the elicitation of values, issues and goals that was then sorted in a small-group setting. Further specification of *actors* and *resources* linked to the key collectively considered values and issues (the *objects*) were then elicited using pre-designed sheets with questions in these small groups. A large group discussion was then used by the project manager to create one list of the key estuarine values.

Following the first workshop, these values (relabelled as *assets* on the estuary manager's suggestion) were used by the researcher as the *points of view* (using the Tsoukiàs model terminology) to produce the *Risk Consequence Tables* to be used in the next workshop. Tables for *Likelihoods*, *Risk Levels* (based on a combination of Consequences and Likelihoods (Wild River and Healy, 2006)), *Knowledge Uncertainties* and *Management Effectiveness* were also produced (the *dimensions*, associated *scales* and a part of the *uncertainty structure* for the evaluation model). This collection of *Risk Tables*, the document review that included 16 key risks developed in large part from the stakeholders' issues (the set of *problem statements*), and the WS1 outcomes were then distributed to stakeholders as the Synthesis Report (BMT WBM, 2007), for their consideration prior to the second workshop. Due to time and competence constraints only a weighted average multi-criteria model developed in Excel was used in the second workshop with the agency and industry representatives. Results of the evaluation model calculated in real-time in front of the participants based on their risk assessments yielded that all risks were either *intolerable* or *tolerable* (and not *acceptable*) meaning that they would require treatment, and hence consideration in the third workshop.

For this risk treatment workshop to define another set of alternatives for action, the researcher was again able to negotiate the use of her preferred decision-aiding technique: her adaptation of Ackermann and Eden's (2001) *Oval Mapping Technique* for the development of risk-treatment strategies and actions. The technique developed specifically for the LHEMP context was also used to investigate and elicit the stakeholders' views on responsibilities for actions (another set of *actors*), what indicators and data could be used for monitoring work towards risk treatment (a set of *criteria*), and their priority actions and strategies (a set of

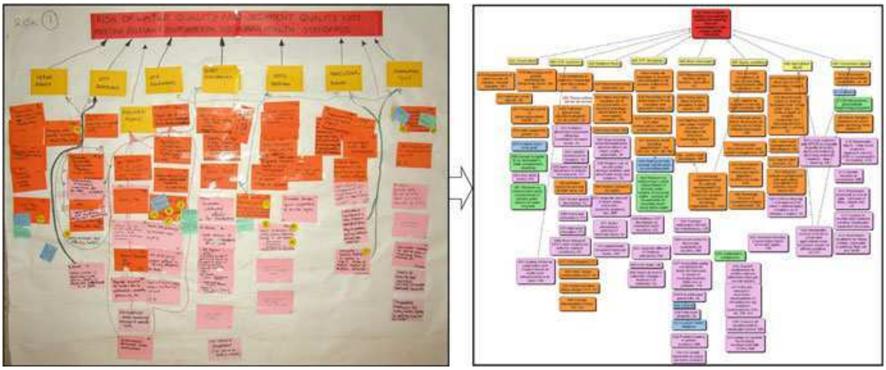

Fig. 8.6 Electronic conversion of an example paper risk treatment strategy map using Decision Explorer®

preference). At the end of the process, the participants' *final recommendations* were synthesized by the researcher to feed into the plan writing. The information from the strategy maps was computerized by the researcher using the Decision Explorer® software, as shown in Fig. 8.6 and exported to Excel to produce a preliminary stakeholder-based risk response (action) table.

This preliminary action table was then considered and compared to existing management plans and regional strategies by the consultants, and a final table of *risk-response* actions created. The final planned actions underwent a secondary risk assessment based on the same stakeholder value (asset) list to determine their potential efficacy for treating the estuarine risks (BMT WBM, 2008; Coad et al., 2007). The draft LHEMP went on public exhibition containing 149 strategies for treating the 16 risks. Of these strategies, 32 were outlined as short-listed strategies which were suggested as having high implementation priority in terms of risk reduction potential (BMT WBM, 2008). After a few minor adjustments to the plan following comments received, the final plan was accepted by the two Councils in the planning area.

During the planning process, another decision support tool was developed by the researcher just after the stakeholder-based risk response table, which could have both practical and research-oriented futures: an *actor-action-resources matrix*, as shown in Fig. 8.7. The tool was designed to help analyse the distribution of actors' preferences for the strategies and actions for risk treatment created during Workshop 3, and to what extent these actors actually had authority to control these preferred actions or the resources to realize them. The eventual aim of the tool was to discover mismatches between priorities and capacities for actors to realize their preferred actions and to determine whether opportunities existed for bi-lateral or multi-lateral negotiations to discuss how any mismatches might be overcome and resources distributed efficiently between actors to meet the most priorities possible.

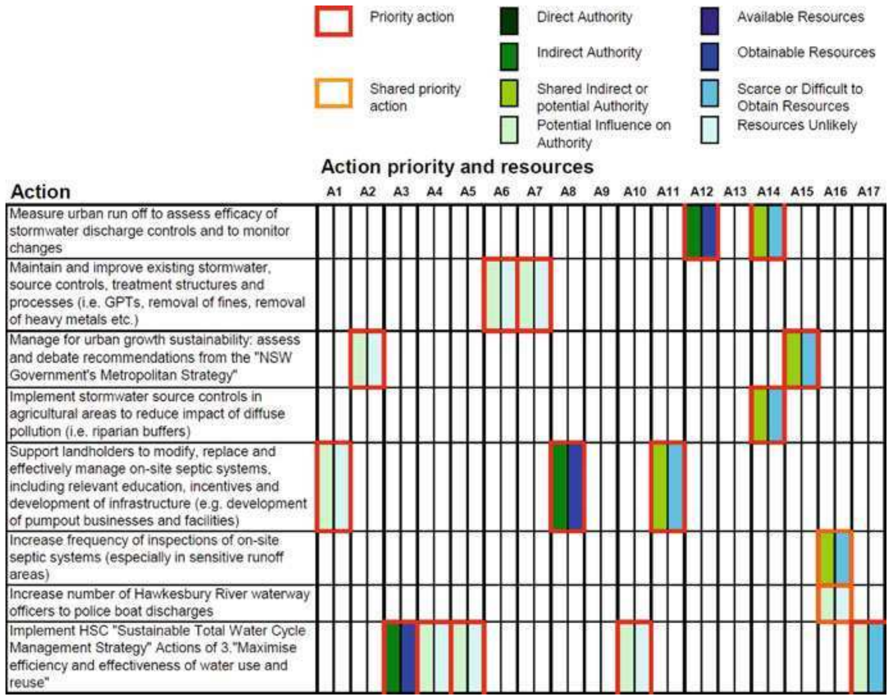

Fig. 8.7 Screenshot of the actor-action-resources matrix tool trialled for the LHEMP

8.4.2 Lessons Learnt

The LHEMP real-world decision-aiding process was a very rich learning experience. However, only a couple of lessons will be outlined here. One of the most important lessons is the need for decision-aiding analysts to be able to adapt their *ideal* theoretical methodologies to the constraints of complex and dynamic political and social arenas. Analysts therefore require not only a solid body of technical knowledge, but also social and political *nous* including strong negotiation skills and a capacity to learn and adapt quickly to changing environments if they are to use their theoretical models successfully.

Due to a range of real-world constraints and new goals and interests entering the planning process, both in its design and implementation phases, a number of methodological ideals, from the researcher's point of view, could not be met. For example, a multi-criteria analysis approach had been suggested in the initial participatory process proposal, with the idea being to construct the evaluation model based on solid decision theory (Bouyssou et al., 2000; 2006; Keeney and Raiffa, 1976; Roy, 1985).

Yet a number of constraints meant that much more rudimentary forms of matrix analysis were used. These real-world constraints included project team members' insufficient proficiency in the methods to make the underlying mathematical assumptions understandable to their colleagues and the participants, and a lack of time to gain and sort weighting or rank preferences. In the end, the risk assessment multi-criteria model used a simple weighted average approach, which as stated in Bouyssou et al. (2000) may compromise the real *meaning* of the final numbers. However, strangely, when the researcher discussed this issue with the other project team members and process participants, it incited little to no reaction. From this case it appeared that, as long as the project team members are seen to have a legitimacy to manage the process and the underlying mathematics of models, the final results will be accepted with ambivalence, as long as obvious discrepancies between intuitive and calculated results can be logically argued. This insight is drawn in particular from the discussion and later acceptance of the low prioritized ranking of the *water quality* risk, which was intuitively labelled as of high or medium priority by all participants (Daniell, 2007b).

On the issue of analysts working as part of a complex social and political arena, there was much evidence that the project team, as well as some core process participants and associated stakeholders, all played a critical role in changing or influencing the direction of the process and the design of methods. Through this project, personal and common objectives on the design needs changed at a number of points through the process, and divergences in the objectives and representations of the process, its interests and its possible futures under different scenarios became apparent. These divergences appeared and had to be negotiated through, despite the fact that a tender had been written and legal contract signed for the project's realization in a particular form. As in other projects, such as in engineering construction, *variations* to the contract on the decision-aiding process could be introduced at any time by any party after the signing of the contract and negotiated until a decision to alter the contract is made. The decision-aiding analysts' role in the process is therefore not fixed just from an initial agreement but must be continuously negotiated and legitimated by other project team members and participants throughout the process. Evaluation procedures for both project team members and participants, as were used throughout the LHEMP (Daniell, 2007b, Jones et al., 2008), can help to determine and aid the building of this legitimacy and early resolution of any problems.

8.4.3 Insights for Theory

This real-world case of decision-aiding also provided us with valuable insights and potential deficiencies or incoherencies in the theoretical decision-aiding participatory structure model (Mazri, 2007) and the process model (Tsoukiàs, 2007). Analysing *ex-post* the iterative process in our case to create and alter the participatory structure which occurred through the initiation, design and implementation phases of the participatory processes, we observed that the iteration loop (*yes/no* decision point in Fig. 8.2) in our case typically occurred after Step 4 rather than Step 3. In other words, full proposals of the participatory structure for decision-aiding were developed before reassessment by the decision-makers in the project team. This shows that the theory of the model based on constructivist principles

(Mazri, 2007), is not necessarily adhered to in reality. Also, due to the multiple decision-makers on the participatory structure design, each element represented in the model was subject to debate. Consensus was not always reached on definitions for each of the elements and each decision-maker often only had a partial, un-negotiated understanding of some elements, such as the resources required for each object of debate. In particular for the risk assessment process, required levels of time and competence for organizing and completing the process could have been better planned. The insights produced from the analysis of the participatory structure design undertaken in the LHEMP show how using explicitly Mazri's (2007) model during practice could promote improvements in shared understanding of the elements and the resulting participatory decision-aiding process.

Using Tsoukiàs' (2007) model in practice also led to a number of insights. These included that many of the elements outlined in the different meta-objects of the model were elicited iteratively through the decision-aiding process and not necessarily in the prescribed order. In particular, the elements of the *evaluation model* were elicited alongside the problem situation and problem formulation elements. One example is that the criteria for assessment in the risk *evaluation model* were developed directly from participants' values elicited in the *problem situation* construction phase, as described above. Another potential issue for using the model in practice was its capacity to be translated or adapted to match topics of interest stemming from other disciplines or decision-aiding methodologies. Linked to the previous example of *values* elicited in the first workshop, it was a challenge to decide in certain cases, such as the value of *good water quality*, if they were *objects*, *resources*, *points of view,* or *preference criteria*. Otherwise, the researcher found the model a useful way to focus her attention on the careful design of methods to be used in the workshops. The *uncertainty structure* element was, in particular, the inspiration for creating an extra *knowledge uncertainty* and the *management effectiveness* categories used as part of the risk assessment model.

8.5 Discussion

Through the theoretical and practical intervention work on decision-aiding outlined in this chapter, a number of key issues to point out in this discussion have emerged. Firstly, the importance of having one or a number of decision-makers (or their close organizational representatives who can carry the decision-makers' interests) involved in co-constructing the decision-aiding artifacts from the beginning of the process should not be underestimated.

From our experiences of participating in and analyzing what took place in the LHEMP decision-aiding process, which resulted in a regionally accepted action plan, we suggest taking decision-maker inclusion even one step further – to attempt to promote decision-aiding processes that are *management-driven* rather than *research-driven*. There is an important difference in both approaches, as in management-driven processes, the decision-makers have already appropriated the process as their own, meaning concrete outcomes are more likely. Of course, exactly which decision-makers are involved in the design, and how they end up biasing the participatory process towards their own interests, could have some negative impacts, including the rejection of final recommendations by other decision-makers or excluded organizations if the co-design process is not adequately managed. There are reasons why some decision-analysts prefer *research-driven* decision-aiding processes, in particular as the researcher(s) or analyst(s) typically have more control over the final decisions of what decision-aiding methodology and methods are used. Keeping this control typically allows analysts to use methods and models that may be more scientifically valid. However, whether future decision-makers will understand them and support the recommendations stemming from the models through to final decision-making is less certain if they feel little ownership over the process and have to carry on the next implementation phases without the analysts' or researchers' help. Considering the need for much real-world inter-organizational decision-aiding, we suggest that supporting management-driven processes are likely to achieve more positive outcomes, even if there are some unfortunate trade-offs for the analysts between scientific validation and stakeholder legitimization of the decision-aiding process.

This means for researchers and decision-analysts that they must become much more effective negotiators in project team meetings to attempt to foster both scientifically valid method use and broad-scale stakeholder legitimization of the processes. They should play an active intervention role in the co-construction of the decision-aiding methodology and its implementation, attempting to allow decision-makers ownership over the process while contributing their specialist knowledge of decision-aiding models and problem-structuring methods to the process.

Another issue of discussion is that multi-stakeholder or inter-organizational decision-aiding processes are often considered to be inefficient in terms of time and other resources for the ends that they achieve (Korfmacher, 2001). However, from the LHEMP case outlined in this chapter, we would contend that *using good decision-aiding theory as a part of effective project team work efforts can support efficient and effective inter-organizational decision-making processes*. Using the available theory, decision-aiding models and knowledge of practical advantages and disadvantages of different problem structuring methods and evaluation model types was a key in the LHEMP intervention to be able to creatively choose and collectively construct methods adapted to the process. Good theory, whether it is tacit or explicit, is invaluable for effective practice, so it makes sense to use the best available decision-aiding theory to inform real-world decision-aiding practice. This opens up a large research field on reviewing, using, and creating decision-aiding theory and models appropriate to aid multi-accountable groups, as represented in Fig. 8.1. The expansion and use of the Tsoukiàs (2007) decision-aiding process model was one example in this chapter of what research in this field could constitute. Operationally testing the Mazri (2007) participatory structure design model in other intervention cases, potentially with the iteration loop after Step 4, is another immediate research need.

8.6 Conclusions

In this chapter we have set out to present what decision-aiding in a participatory situation in the real world, in particular for water management, may constitute. We first outlined the context that this decision-aiding must take place in – *messy* inter-organizational settings – as well as some of the available decision-aiding theories and models that could be applied. An adapted inter-organizational decision-aiding process model based on Tsoukiàs (2007) was developed and was used as the basis of the first author's research intervention in the creation of the Lower Hawkesbury Estuary Management Plan in Australia. The model significantly aided the structuring of the decision-aiding process and promoted insights on its usefulness and validity. The case also provided *ex-post* operational validation of Mazri's (2007) decision-aiding model for participatory structure design, with the exception of one feedback loop. From the case we also justified our claims that (1) we need decision-aiding methodologies to improve inter-organizational decision-making for water management, as well as theoretical models and problem structuring methods that can form useful parts of these methodologies; and (2) we need negotiation skills, amongst others, for putting the methodologies in place in the real world.

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Part III
Technological Bases

Chapter 9
The Internet and the Web

Simon French

9.1 The Early Days of the Internet

e-Democracy and *e*-participation are built on the Internet and the World Wide Web, hereafter simply the Web. We begin, therefore, with a short review of these, their history and their technologies.

On October 4th, 1957 the USSR launched *Sputnik*-1, the World's first satellite, and in doing so, inadvertently, catalysed the invention of the Internet. The USA did not see *Sputnik*-1 as a scientific breakthrough but rather as an evidence of the power of the USSR's missile technology and the potential for spying on the West. The USA response was to set up the Advanced Research Projects Agency (ARPA) to develop new technologies. One of their projects grew into the Internet. Born in the Cold War, the network that ARPA designed had resilience at its core. There were few computers in those days, and many of their locations were known. They could be targeted as vital assets. So a key desideratum of the network was that no computer could be a unique central hub in the network. If any computer or set of computers were lost, the networking between the other computers should continue to work. All would have equal status, and the networking logic, connections and systems should be able to reconfigure themselves while there were any computers and links between them.

It is this resilience which has made the Internet of today so powerful. Computers can join and leave it without affecting the transmission of data across it. If any transmission link fails, the Internet reconfigures itself to get around the blockage by another route. With the many billions of computers connected to the Internet today, this is vital, absolutely vital. Computers are joining and leaving the network by the minute and second. If the Internet could not recognize them, include them and direct files etc. to them without a pause, it would be a slow, unwieldy beast of little use. But, because of the resilience designed into its core, the Internet can reconfigure itself continuously and painlessly. It has become, arguably, *the* essential infrastructure of the digital age.

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But we are getting ahead of ourselves. ARPANET, as the network designed by ARPA was called, eventually went live in 1969. Initially it was confined to defence computers in the USA; but quickly it was extended to academic and research centres. Then, gradually over the next two decades it extended across the public and private sector, and across the world. By 1974 it was called the Internet.

The 1970s saw many developments. In 1970 the '@' symbol was first used as a convention in email addresses, though it would be many years before email was widely used and @ became a global icon for an address. FTP, TCP/IP and other key technologies and standards followed quickly. We shall not dwell on these; vital though they are, they do not add to our understanding in respect of *e*-democracy. But *usenet* does.

Today all the talk is of social media as the next 'big thing', but the roots of social computing are not so new. They date back to 1979 with the invention of discussion boards and usenet. This technology released Internet communications from 1−1 to 1−many emails. It enabled groups to share materials and communicate by posting to a commonly accessible area when other members of the group could access and read them. Users posted messages, articles and later attachments such as photos, code or similar to categorized areas, boards or forums. Other users could comment on these, developing a conversation. Such conversations were threaded so that later readers could follow the development of the discussion. Usenet conversations had some permanency; messages remain on the usenet server and can be read and responded to over the weeks and months after they were posted. Usenet was the precursor[1] of web-forums of today and many other aspects of social networking.

Chat-rooms and *instant messaging* can be traced back to some early work on computer aiding learning systems in the mid 1970s, but in practice only developed and gained popularity during the late 1980s and 1990s. Chat-rooms differ from usenet in that they allow *simultaneous* conferencing, i.e. several people who are online at the same time, can type messages which become visible to the whole group immediately. Messages in chat-rooms are essentially ephemeral; they vanish when the discussants log off. Because of this, chat-rooms only really developed when the penetration of the Internet was sufficiently great that enough people would be online simultaneously. But note again that the chat-rooms and instant messaging so common in our web-based systems of today can trace their roots back to an earlier text-based Internet world.

It is worth noting that the predominant culture among users of the Internet during this period was relaxed. All these developments happened before the growth of personal computers, which really began in the 1980s. The technology was laid down; but the number of users of the Internet was, by current standards, small and generally limited to academics, researchers and others with relatively uncontrolled access to mainframe and mini-computers. Companies could use these technologies and some did, but in the main the development of the Internet in those days was

[1]This is not to suggest that the technological basis of usenet is the same as that of web-forums and other social networking sites; just that there are similarities in functionality as visible to the user.

led by academics and researchers. This is important because it set the culture and conventions of Internet use. It was free, democratic and relaxed.

During the 1980s, the Internet and the number of users expanded steadily. Then came the 1990s and the Web.

9.2 The Birth of the World Wide Web

Between 1989 and 1993 Tim Berners-Lee and his colleagues at Conseil Européen pour la Recherche Nucléaire (CERN – the European Council for Nuclear Research) invented the technology that was to become the Web. They had no thoughts of providing an infrastructure that within a decade would change forever our ways of working, doing business, communicating, sharing ideas or governing ourselves. They did not realize that their innovations would hasten globalization, challenge our legal and economic systems and change our cultures and lives immeasurably. They simply wanted to work together more efficiently.

CERN was and remains Europe's multi-national particle physics research centre. Scientists from across Europe, and indeed the world, travel to CERN in Geneva, perform experiments using the enormous particle accelerators there, and then return home, taking their data and more importantly their ideas with them. In the days before cheap air travel arrived in Europe, it was not easy for scientists to gather together, discuss and collaborate. Science developed in national pockets despite the international collaboration that CERN symbolized, but in practice did not truly catalyse. It was to overcome these geographical barriers to scientific collaboration that Tim Berners-Lee and his team developed the Web. The tools that they created allowed scientists to 'publish' their data, interpretations and ideas, making them available to other CERN scientists across the Internet, who could in turn publish their comments, add to the analyses, linking their and other data so that the sum was greater than their parts. Scientists who had or were going to visit CERN could collaborate and unite in their efforts without continually leaving their national laboratories. They had a tool that was far more productive and inclusive than round robin emails or usenet, which were all the Internet had to offer before the Web.

Tim Berners-Lee's vision of scientific collaboration over Web has borne enormous fruit:

- the Web and its technologies were employed in the Human Genome Project;
- advanced collaboration tools are providing the tools to power large multi-institutional and multi-national research projects (see, e.g., Ludäscher et al., 2005);
- grid and cloud computing are allowing scientists to harness the power of many computing engines and databases connected to the Internet as if they comprised one super computer;
- and a wider approach to research now called *e*-science or Science 2.0 (Waldrop, 2008).

It is perhaps unsurprising that many of these developments are being driven much, much further recently by the opening of the Large Hadron Collider at CERN in autumn 2008.

But it is not scientific collaboration that we shall be discussing: that is another story. Our concern is with the use of the Internet and Web in society and its democratic institutions. Note, however, that the concept of collaboration and shared work was absolutely central to the birth of the Web. Collaboration will be central to our discussions.

As the Web moved from the scientific community to a wider public in the mid 1990s and then exploded into business communities, the concept of collaboration was to some extent lost. The Web that the public saw initially was primarily a set of static pages used to publish information and reports: elements of interaction were limited. Certainly, *e*-commerce and *e*-business applications implied collaboration between business partners in the background, but for the majority of the public, i.e. the customers, interaction in *e*-business was limited to placing an order. There were some web-forums, chat-rooms and discussion groups that nucleated communities. Nonetheless, it is doubtful that many of the public perceived that the Web was an infrastructure to support collaboration. For them it was a vast source of information – and, sadly, misinformation – and a place to order goods cheaply. Email and chat-rooms, implemented through messaging software not the web, were the ways that people interacted socially. Now that is changing. People are talking of Web 2.0, arguing that Web 1.0 was typified by static pages; Web 1.5 by the transactions of *e*-commerce and *e*-business of the dot.com era. Web 2.0 is bringing interaction, collaboration and a change to society through the social networks in which we organize our lives (Ankolekar et al., 2008; Tredinnick, 2006; Wang et al., 2007, see also www.oreillynet.com).

Tim Berners-Lee vision of collaboration has returned, but now to envelop everyone, not just scientists affiliated to CERN. In truth, Web 2.0 is probably commercial hype. The computing industry is prone to grand imaginings of revolutionary developments when all they are really discussing is an evolutionary modification of a technology. But the point is that at last people are beginning to see that what Tim Berners-Lee gave us in the Web is far more about collaboration than about publishing and conducting business transactions. His child is coming of age. But we are moving forward a little too fast.

9.3 The Development of the Web in the New Millennium

The Web was born at the beginning of the 1990s but, much as in the case of the Internet, it remained the province of researchers and academics for its early years. It was not until the mid-to-late 1990s that more than a few individuals or companies had a web presence. Business recognized the Web's potential somewhat before it gained recognition as an infrastructure for social networking; but even then progress was slow, at least by comparison with the pace of developments over the past decade. A survey (Liu et al., 1997) published in 1997 found that of the Fortune 500 companies, almost two-thirds maintained home pages on the Web, which meant, of course that more than a third did not. Thus the Web has only really been a pervasive infrastructure for business for barely 10 years in Western countries and the Pacific Rim and for considerably less in other parts of the World. The explosive growth of *e*-business and *e*-commerce in the late 1990s, the hype and bubble that led to the dot.com boom and bust of 2000, and the subsequent steady establishment of the Web and its technologies as a key infrastructure for business and globalization will not concern us here (see, e.g., Laudon and Laudon, 2009; Pearlson and Saunders, 2006; and Valacich and Schneider, 2010 for a general introduction to these issues). Nor shall we explore the growth of the use by Government of the Web to provide public information, automate transactions with citizens and generally support its administrative functions (Chen et al., 2008). Rather we focus on the development of the Web in relation to personal use, social networking, collaboration and communities.

As we noted, until 2000 or so, for most people the Web simply delivered the long-promised *Information Age*, to pick up a clichéd phrase of the time. By the standards of the mid 1990s there was a wealth of information to be found – although by today's standards the volume of information was miniscule. Sites such as *Yahoo*, founded in 1994, guided people to the information they sought and began to nucleate web communities. *Hotmail*, founded in 1995, provided a relatively simple-to-use web-based email service. By the time it was bought by Microsoft in 1997, it had over eight million users. By the end of the 1990s the Web showed strong signs of becoming a place to shop, particularly for travel and financial products. But it had not yet become the essential infrastructure that changed culture and the way we – particularly the young – interact and socialize. During the 1990s it was the mobile phone that had the bigger impact. The opportunity to communicate without being tied by landlines and the simple immediacy of SMS messaging had begun to network people in novel ways. But the Web and the Internet had yet to achieve and surpass that importance.

During the past 5–10 years things have changed greatly. Broadband connection has increased dramatically in the developed and developing worlds. Mobile and wireless internet connections are pervasive in many countries meaning that increasing numbers of people are online at anytime and thus increasing the possibilities of social networking. Most importantly, the vision of interaction and collaboration as originally conceived by Tim Berners-Lee and his colleagues has finally been delivered in web-technologies. Neat, user-friendly, graphical interfaces allow web-users to interact and collaborate in a myriad of ways. All this has paved the way for Web 2.0.

As we have suggested Web 2.0 is more an evolution of the earlier functionality of the Web: a coming of age. But there are differences in how one views websites. In the early days, the content and functionality of a website were almost entirely designed by the owner. In some ways they were little more than billboards or storefronts. Now they are shaped much more through visitors' activities; some anticipated by the site's owners, some not. Websites are more places to meet, interact and collaborate and as such may be thought of more as meeting rooms and debating halls. Often one refers to Web 2.0 as harnessing collective intelligence, meaning that it does not simply provide content, but allows users to contribute and improve the content. The social encyclopaedia site Wikipedia (www.wikipedia.org) is a prime example of this.

Applications commonly associated with Web 2.0 include

- *Blogs*. A blog, which is a shortening of 'weblog', is an online journal or opinion column in which the author records his day to day activities or reflections, or states his views on a range of topics and readers can leave comments on his or her postings. Already hundreds of millions of blogs have been created.
- *Wikis*. A wiki enables collaboration, allowing users to create, jointly edit and share documents. Wiki is the Hawaiian for 'fast', reflecting the quick and easy way in which such sites can be built.
- *Web-based Collaboration tools*. A wiki is but one way of enabling productive collaboration on the Web. *Google docs*, for instance,[2] allows groups to share the production and editing of documents without the boundaries implicit in the structure of a wiki. In *Google docs* each document can be shared with different overlapping groups, creating a much more loosely structured community.
- *Social Bookmarking*. Social bookmarking sites provide a place where users can point to other websites of interest. Such sites, e.g. www.digg.com or www.delicious.com, offer other ways of exploring the Web than the use of a search engine, particularly in relation to 'what's new' and 'where the action is'.
- *Multimedia sharing*. Sites such as www.YouTube.com and www.flickr.com allow users to share videos or photos.
- *Social networking*. All the above application enable social networking and the creation of online communities, but some, such as www.facebook.com and www.twitter.com, are more concerned with the creation of the network itself than the activities that are supported.

Web 2.0 sites embed one or more of such applications to allow users to achieve some common end. Thus there are specialist blogging sites which simply host their users' blogs. But there are also sites that bring together a range of applications to meet a communities needs. To achieve this they often use a further technology, known as *mash-ups*. Essentially this allows the site owner to combine – to mash up – material and applications from a number of other websites into one web-location. Further technologies, e.g. *RSS* (*really simple syndication*), enable the websites to inform users of current activities and postings that may interest them, prompting them to visit the site and interact with other users. Together these technologies and applications have led to the current growth in social networking and computing, which has done much to invest power on the Web 'in individuals and communities not institutions' (Charron et al., 2006). Those words explain why these developments can underpin developments in *e*-democracy and *e*-participation.

[2]Note that although we only give one or two examples of each Web 2.0 site or application, there are 100s of others offering similar functionality.

Of course the technologies are not standing still; they are evolving and combining. *Google* has announced the imminent release of *Google Wave*,[3] ‘an online tool for real-time communication and collaboration. A wave can be both a conversation and a document where people can discuss and work together using richly formatted text, photos, videos, maps, and more.’ We shall have to see what is actually delivered, but clearly web-based collaboration tools are still developing and becoming more integrated.

Two further, closely related technological developments which we should note are *cloud computing* and *grid technologies*. Although they are intimately connected with the Web and seen as a major component of Web 2.0, they are much more an aspect of the physical infrastructure of the Internet. Cloud computing and grid technologies are the result of a much faster Internet with much broader broadband. Computer scientists will throw their hands in the air at that description, but as a first grasp at the idea, it is a good start. Throughout its short history, computing has been shaped by the balance between cost, miniaturization and power. The earliest computers were built from valves. They were connected together by wires several inches long, and the whole contraption was supported on a framework like some Heath Robinson dream. Their computing speed was governed by the time that electrons spent travelling the wires between the valves, by today’s standards a very long time. The invention of the transistor, followed by the integrated chip over the years has led to the dramatic increases in speed and power because elements of the computer were brought closer and closer together and so the speed increased accordingly. Similarly storage devices (tapes, disk drives, etc.) began as large separate pieces of equipment in their own cases connected to the CPU, the real ‘computer’, by long leads and hence with slow data transfer rates. Miniaturization over the years has allowed storage to be sited much closer to the processor with a resulting increase in speed. Now, in some ways the balance is changing. The Internet is more and more based on fibre optics with photons moving at the speed of light instead of electrons chugging along copper cables. So computers can quickly access data in databases hosted on devices literally on the other side of the planet. Similarly supercomputers which combine many processors working together were originally driven by miniaturization so that the separate processors could be brought closer to each other; and that to some extent still is the case. But the Internet is now fast enough to allow several computers on different continents to work together effectively. This means that computing can be distributed efficiently between different computers across the internet. Grid technologies essentially embody the idea that computers, databases, devices, instruments, etc. can be clustered despite being distributed across the world.

Cloud computing takes the functionality offered by grid technologies and uses it to enable users of the web to draw down applications from a variety of sources. Instead of all of one’s software applications residing on one’s hard-disk or a closely coupled server within a local network, the applications are distributed on servers

[3]Google publicity: www.google.com visited 22/10/10.

across the Internet and downloaded and used as necessary. *Google docs*, mentioned above, is one example of cloud computing and *Google* now offers many applications in addition to the normal office suite ones. Such applications are described as being *software as a service*, recognition that one does not obtain a software licence but rents it as a service as needed. More and more application software is becoming available in this manner, including some mainstream enterprise software, but that will not concern us. All we need note is that boundaries between a user's computer, the Web and other computers on the Internet are becoming blurred. They are all part of a seamless technology which connects users, allows them to share information and work together.

There remains, however, a problem with the sheer size of the Web. Its extraordinary exponential growth in less than 20 years means that even to count the number of web pages at any point in time is a major task. Search engines such as *Google* have a prodigious task searching, indexing and guiding users to pages relevant to their queries; and current search engines accomplish this without understanding the pages that they read. When they read 'pound' they do not know if it refers to a currency unit, a unit of weight or mass or an instruction to pulverize something. To counter this, it has been suggested that we need a *semantic web*, in which the information on each and every page is tagged in some way so that computers can read and 'understand' what the content is about: in a sense, what it means (Berners-Lee et al., 2001). When websites are built according to semantic web design principles, search engines will be able to give richer, more accurate answers, and other links between web pages will be more informative and useful. However, to achieve this, all current pages will need tagging and redesigning to these principles, an enormous task for humankind to do and one that can only be automated if computers can understand what they read, which, of course, they cannot until the semantic web has been created! But new pages can be written to these principles, and older pages can gradually be tagged implicitly, e.g. via social bookmarking. So the semantic web will come in time, and it already has a name: *Web* 3.0!

9.4 The Future

How will the Web develop? Some soothsayers might dare a prediction. We shall not. One can be relatively confident that the current developments will continue apace. Moreover, there is a general feeling that the web will become more 'intelligent' in the sense that the semantic web, Web 3.0, will gradually be delivered. Cloud computing will bring more powerful ways of interacting and collaborating. Mobile communications and Internet technologies will continue to converge allowing yet more access to the web wherever people may be. In that sense 'Martini' computing will arrive: 'Anytime. Anyplace. Anywhere.' But to predict the next great change . . . no, that is not for us. We can expect confidence that the tools, technologies and uses of the Web already established today will achieve much greater penetration across society. Social networking sites first found favour with the younger parts of society,[4] but are already extending across other age groups. For our discussions of *e*-democracy and *e*-participation, such penetration is important. It addresses issues of access, legitimacy and fairness that might otherwise lead to an entrenchment of a digital divide. The power of and access to the Web are now becoming great enough to provide an infrastructure to support a more deliberative democracy.

All this begs one further question: are we ready for all this? For as long as mankind has walked on the Earth, we have lived, worked and played in a three-dimensional world: four dimensional, if we remember time. But no longer. As we have seen, the Internet, the World Wide Web and a vast array of powerful telecommunications have changed that. We are no longer tied to chatting, discussing, deliberating, negotiating, collaborating or whatever face-to-face, meeting together in the same place. We can interact fully over great distances, and, in some sense, we can pause and stretch time. Moreover, while there have been messengers and trade since there were tribes, while there have been telegrams, telephone, radio and television for more then a century, our ability to work together remotely has grown exponentially over the past decade. But the evolution of communication technologies has not been matched by our own evolution. The heuristics, instincts and thought patterns which govern our behaviour were laid down millennia ago, when the sabre-toothed tiger walked the earth and before (Morse, 2006). Our communication skills, our thinking and our understanding evolved in very different times and were arguably ill-suited to the industrial era of the nineteenth and twentieth centuries. How well suited they are to the cyberspace era that now faces us is much more doubtful. Thus there are many discussions to be had on how we should interact in the physical world and its parallel cyberspace of the twenty-first century. But what is certain is that we will be interacting more and more via the Web. It will continue to change the way we socialize, play, do business and run our society.

9.5 Further Reading

The history of the Internet and the Web can be found in many sources. The Web itself, not surprisingly, has many resources – moreover ones that update in pace with its fast moving developments, e.g. webhistory.org (www.webhistory.org), Wikipedia (www.wikipedia.org) and the World Wide Web Consortium (see, e.g., www.w3.org/WWW and www.w3.org/Consortium/history). Most texts on information systems contain an introduction to the Internet and the Web (e.g., Bocij et al., 2008; Laudon and Laudon, 2009; Pearlson and Saunders, 2006; Valacich and Schneider, 2010), while more technical introductions may be found in Deitel and Deitel (2008). Gillies and Cailliau (2000) provide a more focused history up to the turn of the millennium.

[4]With some obvious exceptions such as sites aimed at reuniting old school and college friends, e.g. www.friendsreunited.org.

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Chapter 10
e-Participation: A Discursive Approach

Rui Pedro Lourenço and João Paulo Costa

10.1 Introduction

As described in **Lavín and Ríos Insua**, the idea of involving lay citizens in the process of public policy formulation and decision-making is not new. The demand for public participation is growing and it is primarily justified by the need to limit the "abuses" of the representative and administrative system (Barber, 1984; Pateman, 1970), which underline popular sovereignty and political equality as central values of democracy, and it is sustained by both ethical-normative and functional-analytical arguments. In this regard, better engagement of citizens in the policy-making process is expected to produce better quality policy, build trust and gain acceptance of policy and share responsibility for policy-making (Macintosh, 2003). Public administrations, being responsible for running decision-making processes which directly affect the quality of life of ordinary citizens, "become an important focal point, and some would say battleground, in the discussions over public involvement" (Roberts, 2004). Administrative theory and practice in the last few decades advocate the participation of stakeholders to increase the quality of decision analysis and support for decision-making. The stakeholders may be defined as organisations and individuals whose interests are affected or believe themselves to be affected by the decision-making process. It is assumed that they may provide important high quality information to complement the use of scientific data. Other authors consider that besides expert/scientific and stakeholder information, a public participation process should include the views of ordinary citizens (Renn et al., 1994), considered here as "those not holding office or administrative positions in government" (Roberts, 2004). This ordinary citizen participation is crucial for a number of reasons. First, it allows overcoming the shortfalls associated with stakeholder representation in deliberative institutions (O'Neill, 2001). It is not often easy to identify all interests to consider and find a suitable representation for them. Even then, some citizens may consider themselves misrepresented by those who act as stakeholder representatives

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on behalf of his/her interests. Also, ordinary citizens may prove to be experts in some field where they have experience and/or knowledge at least as relevant as the official expertise (Coleman and Gøtze, 2001; Roberts, 2004). Their potential contribution (such as ideas, comments and proposed solutions) is simply disregarded if they are excluded from the decision-making process. Ultimately, not only the success of implementing the outcome of the process depends on the acceptance by the involved citizens but also it is the cornerstone of democracy that they should influence that outcome (Geurts and Joldersma, 2001).

The adoption of methodological frameworks and the design of participatory instruments and support tools are contingent on many aspects of public participation processes. These aspects include the nature of the problem or issue being addressed, the number, qualifications and heterogeneity of participants, the way each participant has the opportunity to influence the outcome of the participatory process, and the way the participatory process influences the decision or policy under development. Since there is no "fit all" solution when it comes to the design of participatory support tools, it is necessary to identify the most relevant characteristics of public participation processes and analyse the challenges they present to tool design.

Public policy formulation and decision-making processes were, and still are, conducted by public officials and experts. In this context, standard Group Decision and Negotiation (GDN) support, based on decision-analytical (mostly quantitative) methodologies and tools are particularly adequate. It is only natural therefore that attempts were made to extend such support when public decision processes began to consider the involvement of stakeholder representatives and ordinary citizens. However, citizens themselves are accustomed to deal with political matters in a discursive, qualitative way, both within the inner circles of family and friends and the broad public sphere. This gap between the way public officials and administrations work and the way citizens address public issues and problems constitutes yet another challenge for public participation support.

To address such challenges it is worthwhile considering recent developments in Computer Supported Cooperative Work (CSCW), Group Support Systems (GSS), and deliberative (discursive) support tools, and find ways to complement traditional GDN tools. These two areas accompanied the Web 2.0 revolution (see **French**) and extended its support to very large, heterogeneous, ad-hoc, disperse groups. They allow a more discursive and qualitative approach to public participation support and therefore promise to be an adequate complement to decision-analytic methodologies and tools. Nevertheless, difficulties remain concerning the ability of such processes and tools to influence policy shaping and public decision-making and the possibility of integration with other, more analytical and quantitative, tools.

The next section will present some of the distinguishing characteristics of public participation processes that are relevant to support tool design. Section 10.3 will analyse these characteristics, identify the requirements they pose to public participation support and justify the case for a discursive deliberative approach. To further understand discursive deliberation, Section 10.4 presents and discusses how it occurs in the public sphere and how it can influence public policy formulation and decision-making. Section 10.5 presents the evolution of online (discursive) support tools and the efforts being made to integrate them with tools from other research areas, in particular with more formal-analytical approaches. This chapter ends with some considerations about the potential and limitations of the discursive approach and the challenges ahead.

10.2 The Characteristics of Public Participation Processes

Contemporary societies comprise many different types of actors who interact in order to deal with many complex problems and issues that affect the well-being of citizens. These actors can be associated with one of the three distinct but interrelated spheres: the formal politics sphere, the administrative sphere, and the civil society sphere (Grönlund and Horan, 2005; Sæbø et al., 2008).

The formal politics sphere consist of a number of actors (such as political parties, representatives – MPs, institutions – national and local Assemblies) who and which have the responsibility of shaping the policies and defining legislation that will guide administrative action. Within the administrative sphere lies a bureaucratic structure responsible for conducting decision processes in strict observance of the law and policies defined by the political representative institutions. These professional administrations, helped by external experts, were formed to deal with the growing number and complexity of societal problems (DeTombe, 2002).

Taken together, these two spheres are usually designated by *the State*. Outside the State's influence we find the social or civil society sphere comprising "areas of social life which are organized by private or voluntary arrangements between individuals and groups outside the direct control of the State" (Held, 1997).

While governance concerns all three spheres (Grönlund and Horan, 2005), public participation regards the possibility of actors from the civil society sphere influencing the action of the actors from the two other spheres. This participation occurs in the *public sphere*, a concept that although somewhat imprecise – "people do not agree on its meaning" (Schuler and Day, 2004) – it is usually defined and limited to "the social space between the State and civil society" (Brants, 2005). In this context, *e*-Participation may be defined as technology-mediated interaction between the civil society sphere and each of the two spheres that constitute the State (Sæbø et al., 2008).

This distinction between the different spheres, although sometimes artificial, allows us to identify the different sources of public participation processes and the different nature of the issues or problems addressed in these processes. Although there is a difference between public participation processes and mechanisms, the analysis of Fung's "democracy cube" (Fung, 2006) model to categorize participatory mechanisms provides further useful insights on the key characteristics of public participation processes. Other categorizations of participatory mechanisms are described in **Lavín and Ríos Insua**.

10.2.1 The Nature of the Problem or Issue

One of the major aspects that influence the design of participatory processes and support tools is the nature of the problem or issue being addressed. To illustrate this difference it is necessary to look into the two different spheres of the State.

The formal politics sphere is the realm of *politics*, "circumscribed by conditions that impose a necessity for public action, and thus for reasonable public choice, in the presence of conflict and in the absence of private or independent grounds for judgment" (Barber, 1984). Politics is concerned with the *common good* and the decisive political act is that of "engaging in public debate with a view to the emergence of a consensus" (Elster, 1997).

The idea that politics revolve around public action and choice and concerns the pursuit of the common good is in itself a justification (among others) for public participation and for the transferring of the political processes from the "private" formal politics sphere to the public sphere. But it is the presence of conflict and the absence of independent grounds for judgment – "politics is difficult because it emerges within arenas of social groundlessness" (Witschge, 2002) – that reveals the *wicked* (Rittel and Webber, 1973) nature of problems and issues addressed by political processes. These processes are characterized by ambiguous and inconclusive formulations and criteria for judgement difficult to assess (Day, 1997) making them less prone to technical resolution and routine decision-making (Roberts, 2004). Processes concerning this type of problems can be described as "policy formulation processes", in which issues of value assume more relevance than issues of fact. These processes can be considered as a cycle of activities which comprises five stages: agenda setting, analysis, policy creation, policy implementation, and monitoring (Dunn, 1994; Macintosh, 2003).

Public administration officials and experts, the main actors of the administrative sphere, address problems and issues of a slightly different nature and in a slightly different manner. Their action is bound by policies and laws defined by the political actors. Also, since administration actors are generally more technically prepared and analytical inclined than political actors, they deal with issues of fact more than with issues of value. As such they are more involved in decision-making processes than in policy formulation. These processes can be structured in three phases (Holtzman, 1989): formulate one or more decision models, analyse them to explore possible alternatives and decide upon an alternative to implement.

This distinction between policy formulation and decision-making allows for the identification of some key characteristics of different problems and issues, and the different challenges they pose to participatory processes and supporting tools design.

10.2.2 The Characteristics of Participants

The first dimension of Fung's "democracy cube" concerns participant selection: "Who participates?" At one extreme of this dimension he recognizes more exclusive participatory mechanisms, where only elected representatives (professional politicians) and expert administrators (those who staff public bureaucracies) are engaged. This corresponds to the "traditional", "non-participatory" setting and illustrates a context where only a very limited (and somewhat homogeneous) number of participants, who tend to be more analytically inclined and possess the necessary skills to understand and use quantitative models and algorithms, need to be supported.

Moving along this dimension towards more encompassing participatory mechanisms, Fung describes mechanisms addressed to *minipublics* (lay and professional stakeholders or a selected number of ordinary citizens) and those open to everyone (the diffuse public sphere) which correspond to a setting of "full" public participation.

This dimension illustrates the challenges that an increase in scale, heterogeneity and lack of analytical and technical inclinations and capabilities pose to the design of participatory mechanisms and support tool design.

10.2.3 The Internal Influence

The second dimension of Fung's "democracy cube" addresses how participants communicate and make decisions, that is, how do the contributions of participants influence the outcome of the participatory process?

Fung recognizes that some participatory processes aim solely at informing participants, allow them to express their views or, at most, encourage them to explore, develop and transform their preferences and points of view. These processes "do not attempt to translate the views or preferences of participants into a collective view or decision" (Fung, 2006). This means that support for such processes need to focus on information delivery and facilitating interaction between participants and not so much on structuring or producing a final outcome of the process.

The participants' contributions aim at indirectly influence the decision or policy making process by changing other participant's and spectators' points of view, hoping that they will affect upcoming elections and the selection of public officials and political representatives.

Some participatory processes aim, however, at having a more direct impact on the external policy of decision-making process by producing a collective output that reflects the individual contributions. Fung identifies three modes of decision-making that can be used on its own or in a combined way to produce such output (Fung, 2006). In the first mode, individual positions are simply aggregated or a negotiation process takes place. A second mode involves *deliberation*, a process by which individual preferences and points of view are changed solely by the "force of the better argument" (Kemp, 1988), but which distinguishes itself from a "simple" communication mode because it also aims at producing a collective output (deliberation). Voting can be used to produce such an output, but sometimes a simple report is made that reflects the different (consolidated) points of view without attempting to conciliate them. The final decision mode corresponds to the "traditional", "non-participatory" setting where a final decision or policy (output) is produced relying solely on the knowledge and contributions of public officials and experts.

This dimension illustrates the challenges participatory support tools face when it comes to making information available, facilitating meaningful interaction, and, ultimately, producing an output that takes into consideration all the individual contributions of participants. This last aspect is particularly relevant since an opaque method of aggregating individual contributions can undermine participant's trust and take them to question the legitimacy of the process and outcome.

10.2.4 The External Influence

The third dimension of Fung's "democratic cube" addresses the connection between participant's conclusions and opinions (the output of the participatory process) and public policy and action.

The influence of participatory processes on public policy formulation and decision-making processes depends first and foremost on the promoter of the process and its commitment to take its output into consideration. Deliberation about public issues or problems does not always initiate at the politics or administrative sphere. Sometimes institutions from the civil society launch debates on certain issues just as a way to promote their ideas or to foster citizen's civic and democratic formation. Most times however, debates initiating at the civil society sphere aim at exerting indirect influence on government spheres by, for instance, setting the political agenda. In order to do that, these *grassroots* participatory processes need to extend debate from the "private" sphere of civil society institutions into the public sphere. Nevertheless, participatory processes originating in the civil society sphere cover the two least influential settings of Fung's dimension of "influence and authority". The most influential participatory mechanisms, "advice and consultation", "co-governance and partnership" and "direct authority" either originate in one of the government spheres or need their involvement.

The analysis of this dimension is relevant to participatory support tool design because it underlines the different possibilities to influence public policy and action and the different requirements each one poses.

10.3 The Challenges for Public Participation and the Discursive Approach

Policy formulation and decision-making processes were traditionally conducted within the political and administrative spheres by political representatives, public officials and appointed experts without any direct contribution from stakeholder representatives or ordinary citizens.

From a decision support perspective, although possibly there were conflicting criteria to consider, those intervening were regarded as a somewhat small cohesive group that shared a common goal ("the pursuit of the common good") and aimed to base its decisions essentially on issues of fact. They were either analytically inclined or had the capabilities and willingness to use quantitative approaches, possibly with the help of technical facilitators (decision analysts). Essentially all modes of group decision analysis (GDM_{GSEU}, GDM_{vote}, $GDM_{SupraDM}$, GDM_{Fac}, GDM_{Neg}) (French et al., 2007 and **Efremov and Ríos Insua**) could be considered in these contexts, including $GDM_{SupraDM}$ which presupposes the existence of a *supra decision maker* since in some cases a formal hierarchy would exist among participants.

These decision settings are changing. The issues and problems being addressed became more "political" and values gained importance over facts. Stakeholder representatives and a limited number of ordinary citizens became involved in these processes, thus originating less cohesive groups, where participants share different values and hold different views of the "common good", or simply defend different interests. Naturally, conflict potentially rose among the group and particular attention had to be given to the issue formulation and problem structuring phase that preceded model building, since no longer a single shared model would easily gain everybody acceptance. Facilitated modes of decision analysis and soft Problem Structuration Methods (Rosenhead, 1989 and **Franco and Shaw**) were particularly well-adapted to this setting since the (still) limited number of participants would allow for facilitated workshop or decision conferences formats of decision support. Also, negotiation approaches could be used in the same context to deal with the lack of consensus among participants.

These participatory settings have further evolved, and both public policy formulation and decision-making processes were brought to the public sphere, thus allowing every ordinary citizen to participate. This transformation created new challenges to public participation support. The political nature of problems and issues was reinforced by the presence of even more conflicting values and point of views, making consensus more difficult to attain, even when supposedly matters of fact were involved. The scale of participatory processes increased dramatically (involving thousands of participants), and so did the diversity of participants capabilities, which made it difficult to design a unified process and support tool.

Ordinary citizens are accustomed to discuss public issues in a discursive way and distrust analytical models which they consider complex, do not understand and view as a way for technically proficient public officials and experts to "fix" decision processes. Despite the efforts to develop interfaces for preference elicitation and provide support to dispersed groups over the web, the fact remains that the majority of ordinary citizens are not analytically inclined. So, despite the validity of rational-analytical approaches in structuring and supporting public participation processes and the efforts made to develop support tools that would accommodate the diversity of ordinary citizen's capabilities, these approaches need to be complemented by more qualitative and discursive approaches to better fit the qualifications and way of deliberation in the public sphere of common citizens.

The responses to these challenges can be sought off in the GSS and CSCW research areas. These research areas have been devoting attention for long to the question on how to support the interactions and work of groups, including those very large and dispersed, with a high degree of heterogeneity and devoted to different tasks (including brainstorming/idea generation). The Internet has been a development platform for group support systems under these conditions for a long time and the Web 2.0 revolution, with its emphasis on the idea that everyone can "contribute/produce" and not only "consume/listen", has become a more intrinsically democratic medium and proved the merits of self-facilitation, coordination, and collaboration. The success of intrinsically "discursive" social software (*socialware*) tools such as blogs shows that not only they attract a widely (heterogeneous) audience (from the Nobel Prize to the anonymous citizen) but also that people are willing to devote some of their time to engage in discussions in the public sphere.

To understand these proposals and how they can complement more analytical and algorithmic approaches, we need to consider the way discursive deliberation works in the public sphere and how it influences public decision-making and policy formulation processes.

10.4 Discursive Deliberation in the Public Sphere

According to Barber, "at the heart of strong democracy is talk" (Barber, 1984). This idea is shared by many deliberative democrats such as Habermas who took inspiration in early eighteenth-century bourgeois European society, and its informal conversations in public places, including coffee houses, to propose the revitalization of the *public sphere*. Other authors have found that *ordinary political conversation*, even if taking place in the privacy of one's home or the homes of friends and family is significantly correlated with opinion quality and political participation (Wyatt et al., 2000) and that "serious deliberative discussions" can be found in familiar settings (Scheufele, 1999). It seems therefore that *conversation* is the basic tool for political participation and is crucial to the "use of reason jointly exercised by autonomous citizens", the original meaning of democracy (Habermas, 1996).

Political talk in private settings has several limitations regarding the amount of available information, the exposure to diverse (opposing) points of view and arguments, and the possibility to influence public policy formulation and decision-making. One way to surpass these limitations is to consider political talk in the *public sphere*, understood as the "realm of social life in which something approaching public opinion can be formed" (Habermas, 1974).

Habermas devoted much effort to the study of the public sphere, the constraints on public deliberation, and its effects on the quality of democracy. He was concerned with what he called the "scientization of politics" pointing out that "instrumental rationality has invaded and conquered ... social life and politics" (Dryzek, 2000). His efforts were therefore directed to the revitalization of the public sphere by reducing the increasing reliance on technological/scientific forms of rationality and thus "re-politicizing" the public sphere (Webler, 1994). As such, he proposed a theoretical conception, the *ideal speech situation*, which sets the standards for a public sphere were citizens have the guarantee of freedom of assembly and expression, where debate proceeds using critical reason, and public opinion or political will is formed after exposure to sufficient information and diverse points of view (Witschge, 2002) and by the force of the better argument (Kemp, 1988). Only under these conditions public opinion or political will can be distinguished from "mere opinion" (Held, 1995).

According to Habermas' *ideal speech situation* concept and its requirement for discursive rationalism, political talk or conversation would not qualify as proper deliberation. However, Habermas himself was doubtful that the *ideal speech situation* could exist in reality, and some researchers have suggested that, instead, the *ideal speech situation* should be regarded as a standard against which we can measure the existence of constraints on public political deliberation (Kemp, 1988).

While Habermas laid out the conditions for meaningful deliberation in the public sphere, focusing on the process, other deliberative democrats dismiss his requirements for discursive rationalism and define deliberation by its result, "the endogenous change of preferences resulting from communication" (Stokes, 1998), and, therefore, consider other communicative modes to count as deliberation and assume that they can be of importance for democracy (Dahlgren, 2005).

The work of Habermas, particularly his emphasis on deliberation in public spheres, has influenced many theorists of deliberative democracy, for whom "the essence of democracy itself is now widely taken to be deliberation, as opposed to voting, interest aggregation, constitutional rights, or even self-government" (Dryzek, 2000). Deliberation as a social process is considered a type of communication process that involves the careful and serious weighing of reasons for and against some proposition (Fearon, 1998) and whereby deliberators are willing to change their judgments, preferences and views (Dryzek, 2000).

Among deliberative democrats, Dryzek proposes a more critical type of deliberative democracy, termed *discursive democracy* (Dryzek, 2000), that emphasizes the contestation of discourses in the public sphere. Dryzek defines *discourse* in unHabermasian terms as "a shared way of comprehending the world embedded in language", having at its centre "a story line, which may involve opinions about both facts and values" and featuring "particular assumptions, judgments, contentions, dispositions, and capabilities" (Dryzek, 2001). This definition, once again, underlines the importance of language as a primary tool that allows citizens to participate in the definition of public policies, and dismisses the discursive rationalism required by Habermas.

A question remains, however: how do discursive approaches to public participation influence policy formulation and public decision-making? Habermas does not dismiss the role of elections as a mean whereby public opinion can influence the policy practice of the State. As he puts it, "informal public opinion-formation generates 'influence'; influence is transformed into 'communicative power' through the channels of political elections; and communicative power is again transformed into 'administrative power' through legislation" (Habermas, 1996). Dryzek proposes that such transmission can be accomplished by a number of different means, including the alteration of the terms of political discourse, by creating worries about political instability, and by arguments being heard by public officials (Dryzek, 2001). For him, the public sphere is at any time home to *constellations of discourses* and the role of deliberation is to promote reflective choice across them. This process of *contestation of discourses* in the public sphere influences the content of public policy according to the relative weight of these discourses at a given time and place. Therefore, Dryzek proposes to re-conceptualize public opinion as the "provisional outcome of the contestation of discourses in the public sphere as transmitted to the State (or transnational authority)."

Despite its apparent weakness, the influence mechanism proposed by Dryzek finds parallel in the traditional public meetings, where small audiences are assumed to cause a modest impact in public policy. However, public meetings can exert great influence on legislative and electoral outcomes: all that is necessary is that a "good public record of the meeting be kept" (Snider, 2003). This illustrates the need for participatory processes based on discursive approaches to produce an "output" in order to increase the potential to influence public officials.

These results provide a solid starting point for any efforts directed at developing a participatory process or design a mechanism or support system. Since citizens already take a discursive approach to address political (unstructured) issues and problems and public decision-making, participatory methods should take this into account and tap into conversational/discursive methods of participation. This strategy would lower barriers to participation and minimize the demand for citizens' skills, even if only as a prelude or complement to more formal-analytical approaches.

10.5 Online Deliberative (Discursive) Support Tools

The previous section states the importance to democracy of a well-functioning public sphere and the role of discursive deliberation in the public sphere by ordinary citizens in influencing public policy formulation and decision-making. Among the countless efforts to support public participation, we are particularly interested in those that have a discursive approach, even if combined with other more formal-analytical methodologies.

10.5.1 Pre-Internet Tools/Discursive Support

The idea of using technology to support public deliberation is previous to the rise of the Internet. The development and dissemination of radio and (cable) television promised to facilitate access to information, to contribute to the engagement of citizens in community problem solving by supporting the formulation and exposure of novel ideas, and to reduce the need and influence of intermediaries between the general public and public officials (Jankowski and van Selm, 2000). These expectations were perhaps best associated with the idea of *teledemocracy* (Becker, 1981) which promised to use technology in order to revive the Athenian ideal of democracy, by allowing a more direct and periodic participation of citizens in the conduct of public affairs.

Since then, technology has evolved and new forms of deliberative support emerged. Newsgroups in the Usenet (Paolillo and Heald, 2002) and bulletin board systems (BBS) were used as support systems to discuss local issues and access city services in eDemocracy initiatives such as the Santa Monica Public Electronic Network (PEN) (Kavanaugh et al., 2005b). These and other systems can be considered the precursors of the Internet and the World Wide Web with respect to eParticipation.

But the most significant technological development was the Internet, which provided a new set of tools and a development platform to support online discussions. Despite some criticism about the true deliberative nature of discussions on the Internet, a comparative study found that online forums "hold a high level of interactive communication, a high degree of search for communication, diversity of opinions and publics and a moderate degree of argumentation" and "willingness to provide information", thus enlarging the public space (Tsaliki, 2002). Online discussions bear similarities with real-life conversations (Tsaliki, 2002) and, in that sense, they can be viewed as an indication that discursive approaches to *e*-participation provide a smooth transition from face-to-face settings to the virtual world.

To those for whom politics is a topic to avoid in face-to-face discussions with friends, family and strangers, the Internet provides an open forum free of such constraints (Stromer-Galley, 2002), helping to break the psychological barrier of speaking in public, sometimes through the veil of anonymity (Brants, 2005).

Internet seems to be characterized by the same broad core values of democracy, such as freedom of expression, freedom of association (in virtual communities (Cindio and Schuler, 2007), for instance), equality among participants, and an intrinsically participative way of management and development (Cecez-Kecmanovic et al., 2000). As a well-functioning public sphere, the Internet is inherently "open" in the sense that everyone can access it, thus potentiating participation, and discussions can be observed by all, they are visible. It presents opportunities for ordinary citizens to influence the public agenda and make available an unlimited amount of information, which can be consulted easily, therefore improving the conditions for rational reasoning. Also, the interactive nature of the Internet creates the opportunity for dialogue and deliberation (Brants, 2005; Schuler and Day, 2004). Because of these characteristics the Internet is considered to be "at the forefront of the evolving public sphere" and constitutes a "major development in the contemporary history of Western democracy" (Dahlgren, 2005).

10.5.2 The First Wave of Internet Tools – Pre-web 2.0

The more prominent of first wave Internet tools comprised static web pages, *e*-mail (and mailing lists), discussion forums, chat rooms, and web-based bulletin boards. These fairly simple tools, due to their popularity, became the building blocks of virtual or online communities which were aimed at supporting political debate online. The Minnesota Electronic Democracy project (Aikens, 1998) is considered one of the first examples of such type of projects, and it used facilitated *e*-mail based forums to engage participants in discussion of several issues relating to Minnesota politics (Dahlberg, 2001). Compared to other similar initiatives, that project was found to overcome many of their limitations, thus effectively extending the public sphere (Dahlberg, 2001). Its success was due to the formalization of rules and guidelines, self-moderation and focus on local issues (Dahlberg, 2001). Despite the success of some of these initiatives in stimulating deliberation, it was possible to identify some of their limitations: problems of access (centralized place online) and ease of usage, problems of scaling up, and problems of trust and social ties. Also, the same rules that were part of its success also became a discouraging participation factor to some (more knowledgeable and responsible) participants (Kavanaugh et al., 2005b).

But perhaps the most important limitation of these early developed online communities was that the technologies used and the way the process was structured (or the lack of it) did not favour the production of an explicit output: a shared decision or position, or at least a clear representation of the competing points of view (Cindio and Schuler, 2007). This lack of a clear result of the participatory effort not only discouraged further participation but it also hampered the efforts to influence the political process.

10.5.3 Research Developments to Improve Simple Internet Discursive Tools

The experience with online communities highlights both the potential and limitations of these simple discursive tools. Beside scalability problems and the inadequacy to produce a participatory process output, these tools also lack the appropriate mechanisms for facilitation, discourse analysis, contribution selection, organization and synthesis, and support for collaborative efforts on behalf of participants. Deliberation on traditional threaded discussion forums tends to be linear and text based, and discussion is structured with links to and from previous messages, "providing an unsorted collection of vaguely associated comments" (Elliman et al., 2007).

Different research areas attempt to overcome, or at least minimize these limitations and enhance the potential of these first-wave discursive tools by improving them or integrating them with other tools (Sanford and Rose, 2007).

Some improvements came from research areas such as knowledge management, ontology and the semantic web, and content (text) analysis (Paralic et al., 2003). Argumentation Theory also provides concepts for structuring discussions that go beyond the simple question-reply pattern of newsgroups and forums. An implicit assumption is that contributions in a debate represent, or can be split into, argumentation elements that have a nonambiguous type and are organized in a discourse structure (Turoff et al., 1999) or in an argumentation model (Rinner, 2001). These can be divided into "Issue-Based" (Kunz and Rittel, 1970), "Toulmin-based logic" (Toulmin, 1958) and hybrid model schemes depending on the type of structure used to represent the argumentation material (Tweed, 1998).

Taken together, discourse structures, argumentation models, ontology, and CSCW research provide the theoretical base for the development of *discourse support systems* and *Computer Supported Collaborative Argumentation* (CSCA) systems (Gordon and Richter, 2002) which can improve the deliberative nature of public participation. These systems greatly improve the linear structure of threaded discussion forums by facilitating contribution organization and documenting the evolution of the discussion process, building a process memory which helps new participants who enter the discussion and future processes discussing similar issues (Elliman et al., 2007).

These systems can be further enhanced by adopting a graphical representation scheme which allows for visualizing arguments and counter arguments, creating argument maps which facilitate discussion understanding and stimulate participation. Such developments are originating from the Computer-Supported Argument Visualization (CSAV) research area (Elliman et al., 2007; Macintosh and Renton, 2004; Renton and Macintosh, 2007).

Another complementary possibility to develop more advanced *e*-deliberation tools try to integrate these simple and advanced purely discursive tools with proposals from other research areas.

10.5.4 Integration with Tools from Other Research Areas

Geographical Information Systems (GIS) research is looking into participatory approaches to local and regional spatial planning (Evans et al., 2004) and has proposed new types of systems such as Public Participation Geographical Information Systems (PPGIS) (Carver et al., 2001) and Web-based Public Participation Systems (WPPS) (Peng, 2001). These systems integrate a discursive approach with a GIS system and their functionality includes allowing web browsing of documents and static map images, providing communication channels for discussion and voting, allowing interactive map-based queries, scenario building and on-line commenting. They can also be improved by using argumentation models to structure the discursive part component (Gordon and Richter, 2002). The main rationale behind these proposals is that an important part of local policy formulation and decision-making has strong geographical references. The main limitations of these systems lie on the cognitive demands that manipulating GIS systems pose on the common citizen and also on the fact that not all policy problems are geographically related.

Group Decision and Negotiation (GDN) and Decision Support Systems (DSS) research have for long provided a set of decision-analytic methodologies and software tools to help public administrative (bureaucratic) structures and support their decision processes. With the increased demand for public participation, GDN and DSS research began to adapt these methodologies and systems and allow for ordinary citizens contributions into these processes (French et al., 2007; Gregory et al., 2005; Hämäläinen, 2003; Ríos-Insua et al., 2007 and **Benyoucef**). But even these authors recognize that some of these systems, by emphasizing the formulation and exploration of quantitative decision models, are aimed at sophisticated users of decision analysis tools and pose problems of scalability (French et al., 2007). In an attempt to integrate these approaches with more (qualitative) discursive support, French and colleagues propose a *decision-analytic based architecture for e-participation support* which includes a Debate Manager module that would be used to handle and structure user opinions in all phases of the participatory process (French et al., 2007).

Another example of integration between a discursive approach (through the use of a discursive model) and a quantitative decision methodology (a voting mechanism) can be found in the proposal of a Social Decision Support System (SDSS) (Turoff et al., 2002). Under this system, contributions to the debate would have to be expressed as an issue, option, comment or relationship between one of the above – that is, a discursive model. A continuous dynamic voting system would help to filter and organize the submitted contributions.

Another proposal to integrate qualitative, textual contributions into a decision-analytic process is associated with the concept of *e*-cognocracy (Moreno-Jiménez and Polasek, 2003). Such deliberative process comprises two rounds of analytical problem resolution and, in between, a stage of discussion where citizens give their motives and justify the decisions using a collaborative tool (forum). Text-mining techniques are used to determine the motives of preference changes between the two analytical rounds (Moreno-Jiménez et al., 2008).

All these research efforts open up new possibilities to public participation support but they either concentrate on contribution organization and facilitating the analysis and understanding of the process content or they rely on the decision-analytical models to produce an output of the process. They still fall short of supporting the production of a discursive output of the participatory process in accordance with the *constellation of discourses in the public sphere* model proposed by Dryzek.

Elsewhere (Lourenço and Costa, 2006) we propose to model public participation as a collaborative writing process supported by the Internet. In this model, participants express their ideas individually – divergent phase – and then search for related ideas from other participants. Statistical tools help to analyse individual citizens' (textual) contributions and suggest the formation of coalitions between those with similar or complementary ideas and points of view (a common discourse). Step by step, related ideas are integrated into a common document through pairwise collaborative writing efforts – convergent phase. The final outcome would be a set of documents, each of which representative of a certain discourse and jointly produced by a subgroup (a coalition) of participants that share similar points of view. To incorporate citizens' views in local policy-making processes, we propose to use the produced documents as a complement to Problem Structuring Methods (Lourenço and Costa, 2007).

10.5.5 The Web 2.0 Revolution

The Internet and the World Wide Web (WWW) have been from the beginning a development platform for *e*-participation systems. In the recent years, this platform has undergone nothing less than a revolution under the label "Web 2.0" that brought a new set of discursive tools, generically designated by *socialware* or *social networking* software. These new generation of tools is characterized by user-created content (self publishing), the possibility to combine the collective intelligence of users in a collaborative and self-facilitated way, the improved (more interactive and user-friendly) interface of Web 2.0 applications, and more possibilities to collaboratively organize and search through the immense quantities of information available using *social tagging* (Lai and Turban, 2008; Rinner et al., 2008).

The "new" Internet also offers lightweight programming techniques and the possibility to easily combine tools (*mashups*). One such example is ArgooMap (Rinner et al., 2008) that combines Google Maps with a discussion forum and therefore creates a Participatory GIS (PGIS) that aims at supporting deliberative processes that have a spatial component and improve the usability of the GIS for lay users (unfamiliar with the functionalities of "traditional" GIS). This system is also being extended with a voting method to allow the production of an output (decision) (Rinner et al., 2008).

Among the many available systems and *mashup* possibilities, we can identify two of the most prominent tools associated with the Web 2.0 label, web logs (*blogs*) and *wikis*, which appear to have the necessary characteristics to support society-wide deliberation on the public sphere:

- They allow a discursive approach to public deliberation instead of relying on formal decision-making methodologies and thus they require minimum cognitive efforts from the participants;
- They are highly popular, easy to create, maintain and use, thus lowering the technological barriers to participation;
- They may be categorized as collaborative writing tools that could be used not only to support discussion but also to help produce an outcome of the process (e.g. a set of documents summarizing/representing the constellation of discourses that emerge form the deliberative process) that might enhance the influence over public officials.

Regarding the role of blogs within the political system, Drezner and Farrell state that blogs have not only played an important role in scrutinizing politicians' public and private activity ("nailing the scalps of politicians and media figures to the wall") but they have also played a highly important role in shaping campaign tactics and strategy, influencing not just legal issues and politics but also policy outcomes (Drezner and Farrell, 2008). Furthermore, blogs have been used to promote citizen participation in local democracy (Macintosh et al., 2005) mainly because "as a discursive form blogs stand between traditional print and broadcast media and small group discussion" (Woodly, 2008): "they are not just new communication tools; they also provide new rhetorical possibilities for participation" (Kavanaugh et al., 2005b). However, results from previous experiences show that although blogs are recognized as adequate tools for supporting political discussion (divergent phase of public deliberation) they lack the ability to produce a clear output of those discussions (Ito, 2005) and deliberation inherently requires the creation of content (Kavanaugh et al., 2005a).

The main reason for this lack of output suitable creation is that posts are organized in a chronological linear structure, which means that information and ideas posted on blogs quickly lose visibility in a few days. Comments associated with posts, even if organized in a threaded way, quickly get buried along with their posts, some of then clearly off topic or improper. The consequence is that ideas and arguments about a certain topic keep getting periodically repeated because newcomers do not realize that, deep in the archive, those ideas and arguments have already been presented. Nevertheless, the *blogosphere* is today perhaps the most vibrant place in the public sphere where political ideas can be exchanged and discussed.

Like blogs, wikis have been used in a political context, for instance, as a tool to support the making of a political platform (Makice, 2006; Raynes-Goldie and Fono, 2005). Contrary to blogs, wikis are recognized as adequate tools to support the production of joint documents (convergent phase of public deliberation) although they lack the necessary instruments to properly support political discussion. As a consequence, users often do not discuss the changes that they are making and, instead of collaborating to build a common content, they simply engage themselves in "edit wars" merely replacing each other's content (Raynes-Goldie and Fono, 2005). In some circumstances, eventually, these "edit wars" become part of a negotiation process which ultimately leads to a better final product (Viégas et al., 2004). That is the case when a Neutral Point of View policy (NPOV) is adopted and followed, thus explaining the success of projects such as the Wikipedia (Raynes-Goldie and Fono, 2005). But when it comes to "political point-of-view" wikis (Makice, 2006), the NPOV policy is incompatible with the plurality of contemporary political discourses (the conservative vs. the liberal, for instance) which no negotiation process can conciliate.

Given the individual strengths and potential of blogs and wikis, the integration of both these tools seem to be appropriate to support the deliberative process of creation and contestation of discourses in the public sphere. To bridge the gap between them, a *bliki* model (Lourenço, 2008) has been proposed that takes advantage of their potential for discussion (blogs) and document production (wikis). Political discussion (contestation of discourses) should be made primarily through the blog. The formalization of each discourse should be made on the wiki considering the relevant contributions found on the blog. The end result should be a constellation of different discourses about a certain public policy issue/problem. The NPOV policy should be abandoned when building each document on a wiki since political discourses do not constitute "neutral points of view". Further enhancements could include support for stronger peer-to-peer collaboration by providing direct communication channels (chat-like) and synchronous communication/collaborative writing mechanisms to increase the possibilities of successfully creating documents that represent each different discourse.

While the creation of a "visible" output from the participatory process greatly improves the possibilities to influence other citizens and the public officials responsible for the policy formulation or decision-making process, it is necessary to take into account that the number of blog readers is still relatively low in the overall population. Nevertheless, a "common consensus is that blogs play an increasingly important role as a forum of public debate, with knock-on consequences for the media, politics, and policy" (Farrell and Drezner, 2008).

To further increase its influence power, such a tool could be included as a Debate Manager or Problem-Structuring module in a *decision-analytic based architecture for e-participation support* (French et al., 2007 and **Ríos Insua and French**), thus providing an intermediate output that would be taken into consideration by a more comprehensive process.

10.6 Final Remarks and Challenges Ahead

Different issues and different problems require different ways to promote and support public participation. The nature of the issue or problem being addressed is of paramount importance to the design of the participatory process and selection of participatory instruments and support tools. Generally speaking, policy formulation issues (such as the private vs. public configuration of the schooling system) tend to be more complex, ill defined, lacking accepted grounds for evaluation of alternatives due to the importance of *values*, and consequently more difficult to model than decision-making problems (such as the location of a new school). Under these conditions the configuration of the participatory process itself depends on the characteristics and skills of participants, the mechanisms of internal influence (how to produce an output) and the mechanisms of external influence (how does that output influence the policy formulation or decision-making process). This last aspect may be even more important when the participatory process is not being promoted or sponsored by public officials and therefore is not integrated in an official decision process. These *grassroots* participatory processes originate in the civil society sphere and generally do not have the possibility to directly influence public policy formulation or decision-making processes.

All these contingencies make it impossible to prescribe a unique participatory instrument or support tool that fits all requirements. Hence the importance of considering a flexible, configurable process framework and tool architecture. Nevertheless, any proposal that wants to promote society-wide participation in the public sphere must take into consideration that ordinary citizens are accustomed to intervene in politics through *conversation*. In this respect, discursive approaches and (soft) Problem Structuring Methodologies (PSMs) can provide a prelude or an interface to more structured and analytic approaches. On the other hand, Habermas' appeal to introduce discourse rationality in the public sphere should be considered as a gold standard, a desired goal, for participatory process design. Decision-analytic approaches can be used to structure the deliberative process and provide guidelines to help participatory discursive processes to gain rationality. Hence, it seems that the combination of the two approaches may be fruitful for both.

Decision and negotiation support systems have for long been available on the Internet but they lack the softer, qualitative, discursive support needed to address the variety of participatory settings, particularly those dealing with ill-structured, more political issues involving huge numbers of participants (with different skills) in the public sphere. The success and wide acceptance of Web 2.0 discursive tools, with and emphasis on content creation, collaboration and self-organization (facilitation) should provide inspiration to the design of more advanced, integrated, *e*-participation tools.

The integration of participatory approaches and tools originating from different research areas is just one of the many challenges that remain concerning public participation organization and support. Other challenges include dealing with scalability, provide assistance for brainstorming and contribution organization, facilitate relevant information, and help deliberation among participants (Cindio and Schuler, 2007; Kavanaugh et al., 2005a; Macintosh and Whyte, 2008).

But perhaps the most challenging issue regarding public participation is how to influence public policy formulation and decision-making. Ultimately, unless we consider the possibility of embracing direct democracy, the responsibility lies in political representatives and public officials to be responsive to participatory processes. In this context, public participation processes, particularly those emerging from the civil society and conducted in the public sphere, need to be structured in order to maximize their power of influence. This means that support must be given to the collaborative and self-organized production of a suitable ("palpable") output, elaborated in a transparent and trustful way so that the legitimacy of the process is not undermined, considering the different skills and taking advantage of the contributions and collective intelligence of all participants, and preserving some of the dissent that characterizes the plurality of society instead of presenting an aggregated (unified) position. These are indeed difficult challenges to be met. The Web 2.0 discursive tools functionalities, easy of use and popularity open new perspectives to address them.

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Chapter 11
e-Negotiation Systems for *e*-Participation

Morad Benyoucef

11.1 Introduction

The use of information and communication technology (ICT) in day-to-day activities is reaching new heights, creating opportunities and challenges for citizens and organizations. One activity that has recently seen new possibilities for simpler, more efficient, and more transparent processes through the introduction of ICT is negotiation. Negotiation is known as a complex iterative decision-making process (Raiffa et al., 2002 or **Efremov and Ríos Insua**) used to foster consensus whenever individuals or groups are unable to achieve their goals unilaterally (Bichler et al., 2003). Not only can ICT play a role in reaching such consensus, it can contribute to its quality, and hence, to its acceptance by the parties involved in the negotiation. According to (Kersten and Hsiangchu Lai, 2008), ICT can provide negotiators with facilitation, support, and mediation services. The authors define these services as follows. (1) *Facilitation* happens when ICT is used to "enable the [negotiating] parties to communicate, store, and access exchanged information". (2) *Support* occurs when ICT is used to "reduce the cognitive efforts imposed on the negotiators, expand their abilities to assess the [negotiation] problem under consideration, and determine the possible implications of its alternative solutions". (3) *Mediation* takes place when ICT is used to "help the [negotiating] parties in achieving an agreement". It is now customary within the research community to use the term "*e*-negotiation" to describe the three roles played by ICT in the negotiation process, and "*e*-negotiation systems" to depict the applications that embody those roles.

Negotiation is more likely to take place between relatively democratic entities (states or groups) than non-democratic ones, due to the fact that the former are experienced in mediation and compromise, and because they are typically less belligerent towards one another (Dixon and Senese, 2002). Recent developments in ICT in general, and web technologies in particular, coupled with breakthroughs in

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software engineering methodologies and service-oriented architectures, provide real opportunities for citizens and organizations to participate more widely, effectively, efficiently, and transparently in the decision-making process through negotiation. As a result, existing democratic mechanisms could be perfected, giving citizens, and organizations the possibility to be "involved in all phases of decision making rather than solely in the acceptance of an alternative" (Kersten, 2003). This is a step towards achieving electronic democracy (*e*-democracy) (Ríos et al., 2003) and electronic participation (*e*-participation).

E-negotiation systems can be used for political and societal decision making as well as business dealings within the context of electronic government (*e*-government) and business-to-business (B2B). These systems facilitate, support, and automate processes ranging from motion raising and voting to requests for quotes (RFQs). Motion raising and voting (a form of multi-lateral negotiation), for instance, go through the following steps: (1) raising a motion; (2) seconding the motion; (3) amending the seconded motion; and (4) finally, voting on the motion (OMG, 1999). Motion raising and voting can be adequate for a decision-making problem such as when "a government and an ecologist group [discuss] about protocols to recover contaminated lands, with environmental and economical criteria involved" (Ríos et al., 2003). *E*-negotiation systems also support and automate RFQs, an example of the rigorous processes that governments (local, regional, or national) usually go through in order to foster transparency and efficiency in awarding government contracts. Other mechanisms, such as bargaining and auctions, may be used in similar circumstances. When designed and deployed properly, *e*-negotiation systems are supposed to reduce negotiation time significantly by increasing the volume of transactions for a given amount of time, and by removing some of the reticence of humans to engage in negotiations (Lomuscio et al., 2003). Furthermore, these systems promise higher levels of efficiency and effectiveness and foster the emergence of higher quality agreements (Bichler et al., 2003) while lowering negotiation costs (Hurwitz, 2000).

The objective of this chapter is to introduce and discuss *e*-negotiation systems and their design issues. The chapter also introduces and discusses our *e*-negotiation systems design approach, which is based on the service-oriented architecture (SOA) paradigm. Because today's organizations (business, governments) are expanding their online presence so as to reach more users (customers, suppliers, citizens, etc.) and provide round-the-clock service at reduced operational costs, object-oriented design is being replaced by (or augmented with, as some would argue) service-oriented design, where software modules are converted into web services and published over the Internet to be used as-is or to be integrated with other applications. Because web services are based on XML (Extensible Markup Language), they have the advantage of providing platform-independent services which facilitate B2B and application to application (A2A) integration (Benyoucef and Pringadi, 2006).

The chapter is organized as follows. Section 11.2 introduces basic concepts in negotiation and auctions, *e*-negotiation and *e*-negotiation systems. Section 11.3 looks at existing *e*-negotiation systems in the literature. Section 11.4 discusses *e*-negotiation systems design requirements that promote *e*-participation and introduces our service oriented design approach. Section 11.5 provides conclusions.

11.2 Concepts

11.2.1 Negotiation and Auctions

Negotiation is "the key decision-making approach used to reach consensus whenever a person, organization, or another entity cannot achieve its goals unilaterally" (Bichler et al., 2003). The authors of this definition insist on the "iterative" nature of negotiation and the fact that it involves a "communication" component in addition to the "decision-making" component. The "communication" component ensures the exchange of offers, counter-offers, comments, and arguments between negotiators. A negotiation is characterized by a protocol which encapsulates the way "decision-making" and "communication" are performed. A negotiation protocol, therefore, defines the rules of encounter between participants. It "determines the flow of messages between [them] and the rules by which they must abide during the negotiation process" (Bartolini et al., 2002).

Depending on the protocol, there are three classes of negotiations: structured, semi-structured, and unstructured (Bichler et al., 2003). In the absence of a protocol, we talk of unstructured negotiations. When the negotiation follows a protocol that defines precisely the allowable actions of the negotiators, then we talk of structured negotiations. In semi-structured negotiations, negotiators do follow a protocol but the protocol is not fully defined, i.e., the rules of encounter are not strict. Not to be confused with the protocol, a negotiation strategy refers to the rationale for choosing among different actions at a given stage of the negotiation process (Rosenschein and Zlotkin, 1994).

Auctions fall within the category of structured negotiations. They are defined as market institutions "with an explicit set of rules determining resource allocation and prices on the basis of bids from the market agents" (McAfee and McMillan, 1987). Although classifying auctions as negotiations can be somewhat controversial (at least it was about a decade ago), this chapter considers auctions as a form of negotiation. It is worth noting that as early as 1998, Kumar and Feldman (1998a, b) referred to auctions as "business negotiations". In fact they even considered the "fixed-price sale", the catalogue sale as practiced by Amazon.com for instance, as a form of negotiation, albeit a "take-it-or-leave-it" style of negotiation. A recent article by Gimpel et al. (2008) states that the main market mechanisms are catalogues, auctions and negotiations (bargaining), catalogues implementing the fixed-price sale mentioned earlier. According to the authors, although auctions and catalogues are widely used market mechanisms, negotiation remains "the preferred choice when the good and service [object of the negotiation] attributes are ill defined and there are criteria other than price". Indeed, negotiation provides more flexibility for cutting deals than auctions, while auctions provide equal treatment of participants but more competition (Teich et al., 2001).

11.2.2 Negotiation Cardinality

Cardinality describes the number of issues over which participants negotiate, as well as the number of participants (Bartolini et al., 2002; Lomuscio et al., 2003). A negotiation can be "single-issue" if the participants are required to agree on just one issue, or it can be "multiple-issue" if several issues are at stake (e.g., in a labour dispute between a union and management, issues such as salary, pension plan, vacation time, and work conditions could be the object of a negotiation). A negotiation can be "one-to-one" if one participant negotiates with another participant. An example would be bargaining, mentioned earlier, where two parties exchange offers and counteroffers, usually a set of values assigned to the issues being negotiated, until one party accepts the latest offer, in which case an agreement is reached, or until one party decides to walk away signalling the failure of the negotiation. A "one-to-many" negotiation involves one participant interacting with a number of other participants. An example would be an auction involving one seller and many potential buyers. Finally, in "many-to-many" negotiation, several participants are involved with other participants. An example would be the motion-raising process mentioned in Section 11.1. It involves participants meeting to make a decision. The process starts with a motion being raised and ends with a vote that determines whether the motion is accepted (agreement) or rejected (disagreement). It is important to note that several parties (citizens or organizations) can be arranged to participate as a group in a "one-to-one" negotiation as long as unique offers and counteroffers are exchanged between the both groups (Lomuscio et al., 2003). In a democratic process, before offers and counteroffers are submitted, they are usually agreed to by the group through consultation and possibly a vote.

11.2.3 e-Negotiation and e-Negotiation Systems

Electronic negotiation (*e*-negotiation) takes place when information is exchanged via electronic means. This rather broad statement enables us to talk of electronic auctions (*e*-auctions) and electronic catalogues (*e*-catalogues) within the same context.

One of the first publications to address *e*-negotiations, without actually referring to it as such, states that business on the Internet "will rapidly expand to include the negotiations conducted to settle the price of the goods or commodities being traded" (Kumar and Feldman, 1998b). It should be noted that the "electronic means" mentioned in our definition of *e*-negotiation include, but are not limited, to the Internet. A more complete definition would therefore be: "*e*-negotiation takes place when the negotiation process is enabled and supported by Information and Communication Technologies (ICT)" (Strecker et al., 2006). ICT includes software, hardware, and networks such as intranets, extranets, and the Internet.

The meaning of the term *e*-negotiation can also be derived from various descriptions of *e*-negotiation systems found in the academic literature. Here is a sample: an *e*-negotiation system is "capable of supporting, aiding, or replacing one or more negotiators, mediators or facilitators" (Kersten and Noronha, 1999); it allows for "more activities undertaken in negotiations to be supported, including efficient matching of potential negotiators, exchange, comparison and categorization of rich data, and the use of tools for data collection, problem structuring and analysis and interpretation of offers" (Strecker et al., 2006); and, it is "deployed on the web for the purpose of facilitating, organizing, supporting and/or automating activities undertaken by the negotiators and/or a third party" (Kersten and Hsiangchu Lai, 2008).

Undeniably, the role that ICT plays in negotiations goes beyond the use of electronic communications to actually change "the way a negotiation problem can be represented and a negotiation process structured" (Bichler et al., 2003).

There are three types of *e*-negotiation systems (Bichler et al., 2003): (1) negotiation support systems assist users with communication and decision-making activities; (2) *e*-negotiation media provide a platform that implements a negotiation protocol; and (3) negotiation software agents replace users in their communication and decision-making activities. In this chapter, we only discuss the last two categories and we refer to them as "*e*-negotiation servers", and "automated *e*-negotiation interfaces", respectively. Their missions are detailed below.

E-negotiation servers implement and enforce a negotiation protocol such as motion raising and voting or bargaining, and constitute the virtual place where participants meet (usually over a network, since nowadays most of these systems are web based) for decision making, conflict resolution or business negotiation. These systems are provided by governments or businesses and are often augmented with services ranging from registration and authentication to non-repudiation.

As their name indicates, automated *e*-negotiation interfaces form the interface between the user and the *e*-negotiation server. The interface can be as simple as a web browser, in which case there is little or no automation to talk about. Otherwise, the interface can be quite elaborate, providing tools for automating certain negotiation tasks and/or performing activities for the user. In this case, the system is usually built around the concept of software agents, – i.e., computational entities that participate in the negotiation on behalf of the user. We see the automated *e*-negotiation interface as a framework where software agents reside and perform negotiation tasks. The degree of automation provided by the interface depends on how much autonomy these agents have. They can be instructed to report to the user each time they are faced with a major decision (e.g., whether or not to make an offer) and wait for a cue from the user on how to proceed. Or they can be provided with enough knowledge enabling them to make major decisions (e.g., walk out of a negotiation when the chances of reaching a favorable deal are slim). The literature talks of semi-automated and automated negotiations, respectively, when dealing with the abovementioned situations, but, in this chapter, we talk of automated negotiation to mean both. It is important for the automated *e*-negotiation interface to ensure that (1) software agents have sufficient knowledge about the issues that are the object or the negotiation; and (2) software agents are able to rate their preferences in order to evaluate and choose between different deals and situations (Lomuscio et al., 2003).

11.3 A Review of *e*-Negotiation Systems

In this section, we review briefly some of the most successful *e*-negotiation systems found in the academic literature.

GNP (Generic Negotiation Platform) (Benyoucef et al., 2000) is a web-based *e*-negotiation system designed to support various negotiation protocols, which are described in a uniform way, enabling them to be exchanged between participants. A negotiation is orchestrated as a sequence of rounds. At the start of each round, participants receive sets of public and private information, as well as actions to select from. A new round is initiated, either when a predefined number of participants have submitted their choices, or after a deadline has expired. At the end of a round, a script is invoked to process the participants' responses and generate the messages to be sent to them to start the next round. The script represents the negotiation protocol. Therefore, the architecture of the negotiation platform is independent of any specific negotiation style. A negotiation is treated as a document: every interaction is a manipulation of that document. A two-level API (Application Program Interface) called the Negotiation Toolkit is provided to manipulate this document. The first part of the toolkit consists of storage management functions, such as loading, searching, and saving information about the negotiation. The second part provides functions and objects that are frequently needed by the negotiation designer.

Negotiauction (Teich et al., 2001) is a system that combines multi-attribute auctions and negotiations (bargaining). The system enables the auctioneer (auction owner) to specify price discounts as well as other constraints on participants. Furthermore, the auctioneer may use the system to negotiate (bargain) with participants, thus balancing bidders against each other with the aim of making the auctioning process more efficient for all participants. The system's design features include multiple issues (not just price); the possibility to discriminate among participants; suggesting prices to bidders; and bargaining.

SilkRoad (Ströbel, 2001) aims at facilitating the design and implementation of *e*-negotiation systems for specific application domains. It enables multi-attribute negotiations through a design methodology and a generic architecture with reusable negotiation support components. A system built on the basis of the SilkRoad architecture acts as an intermediary between the actual negotiating agents (human or software) providing rule-driven communication and decision support.

GeNCA (Generic Negotiation of Contracts API) (Mathieu and Verrons, 2004, 2005) is a negotiation model and API aimed at facilitating the design and development of *e*-negotiation systems. It is built on three levels: communication, strategic, and negotiation levels. The communication level defines the primitives needed to exchange messages between participants. The strategic level is separated from the other two levels to allow the user choose which strategy to employ without disturbing the remaining application components. The negotiation level consists of the negotiation protocol and the negotiation management. The protocol is an extension of the contract net protocol (CNP) (Smith, 1980). The following parameters, stored in a configuration file, specify the protocol: the number of agreements needed to validate the contract; the answer delay and the default answer; the number of rounds in the negotiation; the possibility of retraction; and the number of renegotiations allowed. The API also provides some implementations of the communication level such as *e*-mail communication, as well as some default negotiation strategies and tools for creating new ones.

INSS (International Negotiations Support System) (Wu et al., 2006) is a web-based *e*-negotiation system that allows participants to negotiate over open and dynamically modifiable problems using different strategies and tactics. The negotiation protocol allows negotiators to formulate their own negotiation problem and specify the process, as well as the permissible activities of the participants. It also allows for the negotiation issues to be modified.

CAME (Computer Aided Market Engineering) (Neumann et al., 2005) is a design framework for electronic markets. It uses a generic auction process that is configured using a market modelling language (MML) to automatically generate an executable auction platform. The framework was used to build meet2trade, a generic platform for negotiation enabled markets. The meet2trade platform enables users to configure their own electronic market by selecting trading features, and supports agent-based experiments and simulations (Weinhardt et al., 2005). Contrary to the abovementioned projects, this framework focuses on auctions and not on protocols capable of implementing political or societal decision-making, such as bargaining, for instance. However, the approach taken here is interesting because it aims at supporting the design process at the conceptual level, by helping the user with the choice of interaction rules, i.e., protocols.

11.4 Designing *e*-Negotiation Systems for *e*-Participation

In this section, we discuss design requirements for *e*-negotiation systems, we propose a high level service oriented design that aims to meet those requirements, and then we report on an implementation of the proposed design.

11.4.1 Design Requirements

A change in the political or social environment might call for a modification in the negotiation protocol used to resolve political or social disputes. It is, then, important that an *e*-negotiation system allows for quick and easy deployment of the new negotiation scenario brought on by the change, preferably at reduced setup cost (Neumann et al., 2003). One way to achieve this is by separating the protocol from the system that implements it. Consequently, the *e*-negotiation system's designer should be able to use standardized tools to select a protocol from a repository, i.e., a library of protocols, – or to specify a new one – and deploy it. Separation usually fosters reuse as well as efficient and easy implementation, deployment, and testing.

To achieve separation, negotiation protocols need to be specified via shared ontologies (Phelps et al., 2004). This is true for *e*-negotiation servers as well as automated *e*-negotiation interfaces. The reality, however, is that most of today's *e*-negotiation systems support a single negotiation protocol which is usually hard-coded into the *e*-negotiation server and in the software agent(s) that constitute the active part of automated *e*-negotiation interfaces (Bartolini et al., 2002). When a new negotiation protocol is introduced, then a time-consuming and complex process of implementing it on the server takes place. All users are subsequently required to adapt their automated *e*-negotiation interfaces to the new protocol (Rinderle and Benyoucef, 2005). Having a shared ontology of protocols will enable the interface to connect to any server, regardless of the negotiation protocol currently implemented. Additionally, protocols can be consulted by participants prior to engaging in the negotiation, hence contributing to the transparency of the negotiation process. Requirements for a specification language for negotiation protocols include expressiveness, completeness, formalization, verification, automation (the specification must be executable), large scale acceptance, understandability, and compactness (Benyoucef and Keller, 2000).

From a software engineering perspective, *e*-negotiation systems usually consist of components with well-defined interfaces. Regarding the limited lifecycle of these components, they should be easily interchangeable. Instead of rewriting the entire application, only a single (or a few) component(s) must be replaced. If the core component (called engine or shell) is domain independent, it can be optimized in terms of scalability, security, and processing time (Neumann et al., 2003).

In addition to higher process efficiency and lower transaction costs (Malone et al., 1987), users look for the following features in *e*-negotiation systems (Cass et al., 1999): (1) Correctness: the system should allow no errors, deadlocks, or incorrect handling of exceptions. (2) Reasonability: the system should allow for adequate time for offers and counteroffers to be formulated. (3) Robustness: the system should continue to function properly after an interruption or improper action from the user. (4) Rapidity: the system should execute and respond relatively quickly. (5) Traceability: the system should be designed with the capability to explain its actions to the user whenever the user is in need of an explanation. (6) Integration: it should be possible to easily and quickly integrate the *e*-negotiation system with other applications (Benyoucef and Verrons, 2008).

Finally, an *e*-negotiation system should be easily accessible to users (citizens or organizations), intuitive to use and affordable. It should also be customizable and should guarantee the security and privacy or the users' data in storage and while it is transferred across the network.

Meeting these design requirements will create an environment of trust between the community of users and the providers of *e*-negotiation systems. The ability of these systems to support transparent and efficient decision making through innovative negotiation protocols will create new political opportunities for all citizens and organizations. Benefiting from a wider access, facilitated by ICT, citizens, and organizations will be able to achieve better agreements faster and with less effort, marking a step towards real *e*-participation.

11.4.2 Service-Oriented e-*Negotiation Systems*

Several organizations (business, governments) are making their software applications available on the web using the SOA approach, which is usually, but not necessarily, built around the concept of web services, in order to interact more effectively and efficiently with their users, customers, citizens, partners, suppliers, etc., and to achieve higher levels of integration and automation at lower costs. Similar to other enterprise applications, *e*-negotiation systems should therefore be exposed as services on the web to enable the providers and users of such systems to benefit from the known advantages offered by the SOA approach.

Why is the SOA approach well indicated for designing *e*-negotiation systems? First, an adequate automation solution for *e*-negotiation processes must be based on the separation of the process logic and the program code of the invoked applications, as realized, for instance, in workflow management systems (Reichert and Dadam, 1998). Second, an important requirement for the automation of *e*-negotiation processes is the proper support of interoperability between the processes of the negotiating parties. To meet such requirements, the dynamic invocation of web services within a SOA solution is the most appropriate approach (Kim et al., 2003). Using SOA also supports the interoperability between the negotiating parties' internal as well as external systems. Moreover, relationships between negotiation partners are dynamic, therefore run-time binding is better than design-time binding (Kim and Segev, 2005). But since web services are stateless, web service orchestration languages (e.g., BPEL – Business Process Execution Language) and web service choreography languages (e.g., WS-CDL – Web Services Choreography Description Language) have been introduced to compose the services into long running processes.

Our high level design framework for service oriented *e*-negotiation systems is presented in Fig. 11.1. As can be seen, there are two main categories of *e*-negotiation systems. The *e*-negotiation server implements a negotiation protocol and is usually provided by a business or a government, depending on the server's intended mission (business or political/societal decision making). The automated *e*-negotiation interface enables a citizen or a business to participate in the negotiation that takes place on the server.

A user interface is important on both the server and the automated interface. It enables a designer to configure a new negotiation on the server and a user to participate in the negotiation through his/her own automated *e*-negotiation interface. A process modelling component is used by the designer to model (graphically if possible) a negotiation protocol, test it, and then add it to a repository of negotiation protocols. The process execution component is the engine that runs (enacts) the negotiation process, and the process monitoring component enables the administrator of the server to control and monitor the execution of the negotiation process. Through the integration component, the *e*-negotiation server and the automated *e*-negotiation interface can be integrated with the back office systems of the provider and the user, respectively. This integration is necessary, for instance, when information from internal databases is used in the decision-making process. Several services

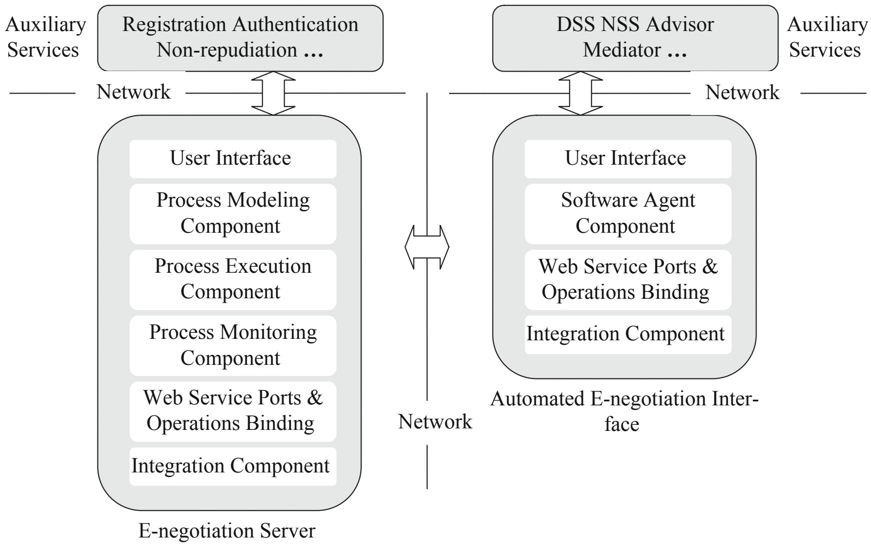

Fig. 11.1 Design framework for service oriented *E*-negotiation systems

are needed on the server side to complement the negotiation service. Some examples are as follows: registration services for participants; authentication services to make sure participants are truly who they say they are; and non repudiation services to prevent a participant from backing away from a commitment. Other services may be offered and the provider of the negotiation server can choose the ones to bundle with the original negotiation service. On the client side, the negotiator can compose several services to augment the ones offered by the automated *e*-negotiation interface. Examples include DSS (decision support system) services providing decision support to the user and NSS (negotiation support system) services used by the participant to rate offers and evaluate counteroffers before submitting them to the opponent; Advisor services used by the participant to ask for and obtain advice on legal, business, and other matters in relation to the deal being negotiated; and mediation services. If automated negotiation services are provided, it is within the Software Agent Component that the negotiating software agents are created, invoked, controlled, monitored, and their actions terminated. Every interaction between the *e*-negotiation server and the automated *e*-negotiation interface is executed through web service ports and operations.

Based on our proposed design framework, we implemented a prototype using web service orchestration, which, as mentioned earlier, represents one way of composing and coordinating web services to obtain higher-level business processes that can be deployed and enacted on the *e*-negotiation server. BPEL is an orchestration language that describes how web services interact with each other at the message level and tracks the sequence of messages including the business logic and execution order of the interactions (Peltz, 2003). BPEL is designed to address the orchestration complexity, thereby reducing cost and time-to-market and increasing the overall efficiency and accuracy of business processes. It stands as one layer on top of WSDL (Web Services Description Language). While WSDL describes the messages' data types, port types, allowed operations, and partner roles, BPEL describes partner bindings, incoming and outgoing variables, and operation logic sequences. BPEL supports common repetition (while-loop), selection (if-then-else, select-case), error handling (try-catch), and parallel processing.

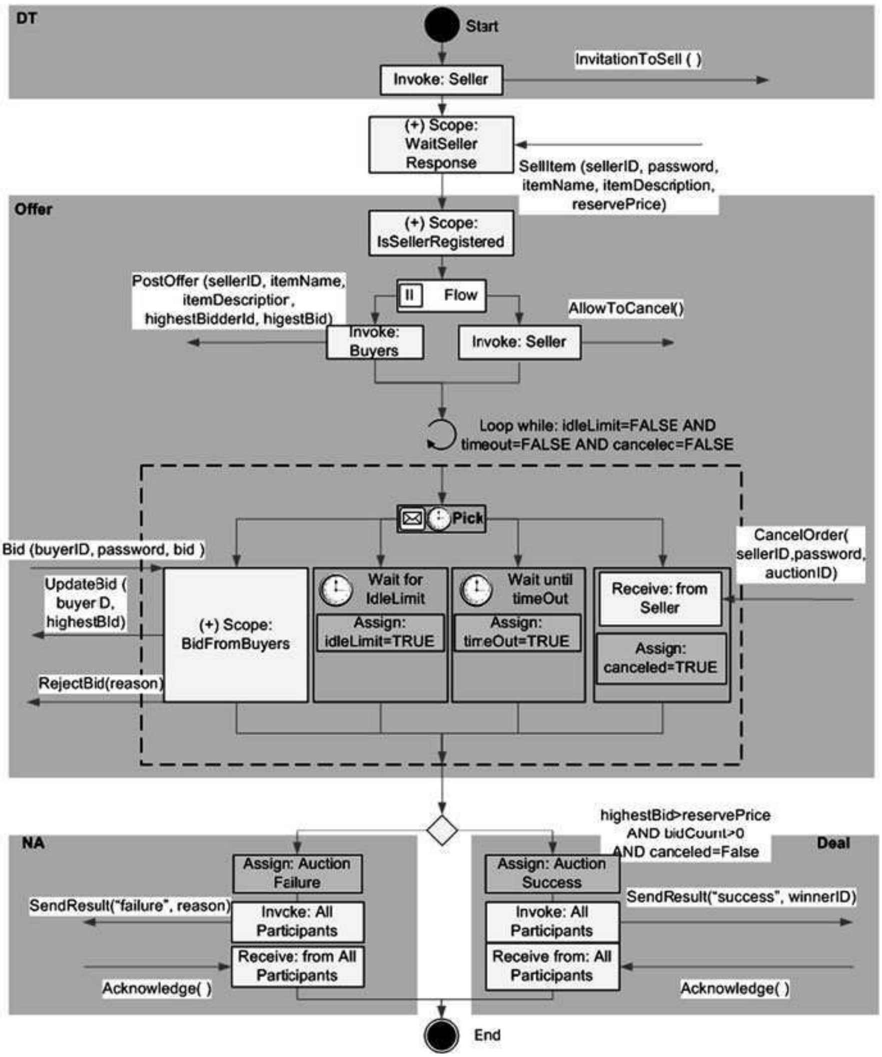

Fig. 11.2 BPEL diagram of the English auction – Part 1

The BPEL engine, which is the equivalent of the process execution component shown in Fig. 11.1, is the core component of the *e*-negotiation server. Participants access all the services offered by the *e*-negotiation server through the BPEL engine. Each participant, through his/her own automated *e*-negotiation interface, communicates with the server and joins the negotiation by accessing the BPEL engine, using the WSDL file, and by calling the available services using their operation names and passing the necessary variables to them.

Figure 11.2 shows the BPEL process description of the English auction. In the diagram, we use the scope-and-expand method. A scope is a collection of activities represented by a plus sign "(+)" that can be expanded into a subsequent activity diagram. We assume that all participants have completed the registration process before the start of the auction. Therefore, the registration process does not appear in the diagram.

The "Scope: WaitSellerResponse" is a collection of activities that wait for a response from a seller for a certain amount of time, ensuring that he has enough time to respond. The expansion of this scope is shown in Fig. 11.3a. After receiving an "item to sell" message from the seller, the server will check whether the seller is registered or not. If the seller is not registered, the process does not proceed

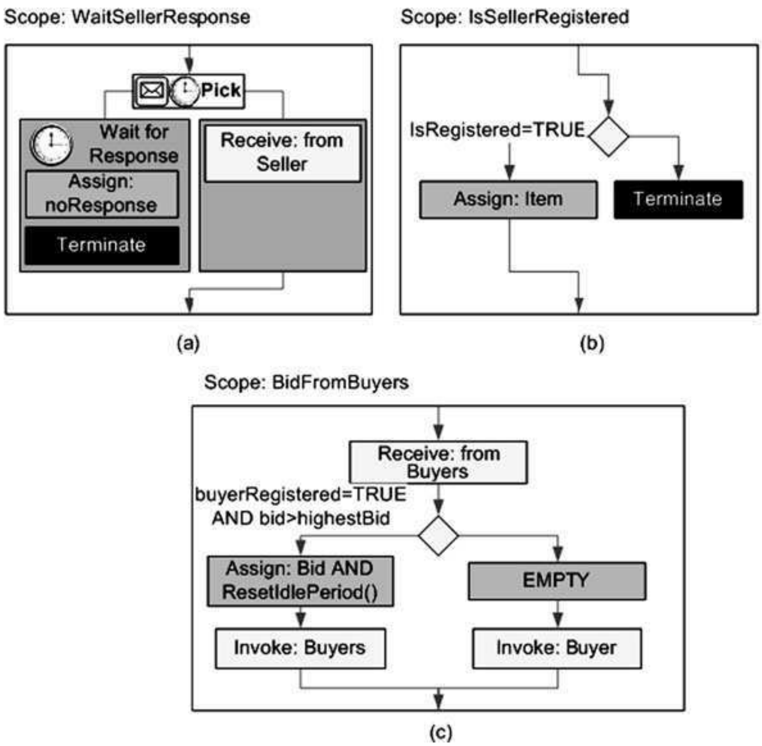

Fig. 11.3 BPEL diagram of the English auction – Part 2

(Fig. 11.3b). Otherwise, the server executes a parallel flow to initiate the bidding phase by invoking the seller so he can cancel the auction if he wishes to do so, and by posting the item so that buyers can start bidding on it. The bidding phase is a loop mechanism. In the English auction, the activities that can happen during the bidding phase are as follows: buyer bids (back to loop); seller cancels (out of loop); and auction reaches its deadline (out of loop). To replicate the "going-going-gone" found in off-line auctions, we introduce another variable into this phase: idle time. If there is no incoming bid after a certain amount of time, the bidding phase ends (out of loop). These four activities are guarded by a pick construct. The server checks for the authenticity of bidders and verifies the validity of their bids (Fig. 11.3c).

At the end of the bidding phase, a switch construct will decide whether the auction was successful or not. It is successful if the highestBid is more than the reservePrice; there is more than one incomingBid; and the seller does not cancel the auction. An outgoing message will inform participants of the result of the auction.

It should be noted that we deployed and tested several negotiation scenarios, but there is not enough space here to report on all of them. The English auction gives a good idea on the expressive power of BPEL and web service orchestration languages in general for modelling and enacting negotiation scenarios. This implementation is a small and quick step towards the validation of our proposed service oriented design framework for *e*-negotiation systems; however work is still ongoing to perform a thorough validation.

11.5 Conclusion

In this chapter, we discussed *e*-negotiation systems and their design requirements. We identified two categories of *e*-negotiation systems: servers, where the negotiation takes place, and interfaces, which are client applications used by negotiators (citizens or organizations) to connect to the server in order to participate in the negotiation. The interfaces also offer automation services in the form of software agents that can perform negotiation tasks on behalf of the users. We identified a set of design requirements for *e*-negotiation systems, key among them is the possibility of visually modelling a negotiation before it is deployed on the server and made available to negotiators. The resulting model is then added to a repository of proven and tested negotiation protocols that can be deployed on the server anytime by clicking a button. We proposed a high level service- oriented framework which satisfies most of the design requirements. Finally, we reported on an implementation of the proposed framework built on the BPEL orchestration language for modelling and enacting negotiation processes. Our approach reduces the need for the *e*-negotiation designer to understand programming concepts, allowing him to focus on the business view of the *e*-negotiation system. Our approach also promotes loose coupling and reusability. Moreover, with open interfaces such as web services, *e*-negotiation services as well as auxiliary services are platform independent.

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Chapter 12
Web-Based Decision Support: Creating a Culture of Applying Multi-criteria Decision Analysis and Web-Supported Participation in Environmental Decision Making

Raimo P. Hämäläinen, Jyri Mustajoki, and Mika Marttunen

12.1 Introduction

In recent years, the importance of public participation has increased rapidly in environmental planning and new practices and methods have been developed. Public participation is changing from one-way communication between authorities, experts, stakeholders and citizens toward two-way interaction (e.g. Beierle, 2002 or **Lavín and Ríos Insua**). The change in the planning culture sets new challenges for project planners and managers, as the planning process should incorporate differences in the values and knowledge of different stakeholders.

This chapter introduces a framework for the use of multi-criteria decision analysis (MCDA) tools and web-based communication to support public participation in environmental planning. The framework has been constructed on the basis of our experiences obtained from four lake regulation projects in Finland. The applicability of the framework to meet the objectives of participation is evaluated against these experiences. We focus on environmental planning, but the results could be adapted to other areas of participatory planning as well.

MCDA is a structured approach to systematically analyze complex decision making problems. The aim is to identify the essential objectives and attributes of the problem and, by structuring and analyzing these systematically to obtain a comprehensive view of the problem. In group decision making, this makes it possible to analyze different views of the stakeholders in a unified setting to increase the transparency of the process and achieve a common understanding of other stakeholders' objectives. The MCDA approach can be useful especially in environmental decision making, as the views of the stakeholders are typically diverse and even conflicting. MCDA methods have been successfully applied in many environmental problems (see e.g. Anderson et al., 2001; Gregory and Wellman, 2001; Kangas et al., 2008; Keefer et al., 2004; Kiker et al., 2005; Marttunen and Hämäläinen, 1995, 2008; McDaniels et al., 1999; Mustajoki et al., 2004; Salgado et al., 2009).

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The Internet provides various opportunities to support communication in participatory processes. The web can act as a communications channel in both informing the public and collecting the feedback, and *e*-mail can be used to personally communicate with the participants. In environmental planning, the possibilities of the Internet are especially attractive, as the stakeholders usually live in different areas and the Internet can be a means to involve larger numbers of citizens. For examples of applications of Web supported communication in environmental planning, see e.g. Kingston et al. (2000), Kangas and Store (2003), Tang and Waters (2005) or Voinov and Costanza (1999).

This chapter deals with an approach in which a steering group is set up to represent different stakeholder groups. The work of the steering group is facilitated by experts in multi-criteria decision analysis and environmental issues. The aim is to get a shared understanding of conflicting issues by identifying objectives and eliciting the group members' preferences with MCDA methods and by discussing these collaboratively. The public is involved in the process by organizing public meetings and hearings as well as by carrying out questionnaires and interviews in different phases of the project. Internet technology can be used especially in informing the public and in collecting the feedback, but it also makes possible the independent use of MCDA software on the web. However, in practice it is questionable whether the public can be adequately educated to properly use the methods and software on their own. We shall also discuss this issue.

We discuss the applicability of our framework in terms of the objectives presented by Beierle (1998) for evaluating the success of public participation programs in environmental decision making. The evaluation is based on six objectives: (i) informing and educating the public, (ii) incorporating public values and knowledge into decision making, (iii) improving the substantive quality of decisions, (iv) building trust, (v) conflict reduction, and (vi) cost-effectiveness. Morgan (1998), French et al. (2005) and Kangas et al. (2008) provide other perspectives in which attributes such as fairness, openness, transparency, and legitimacy are used to characterize the success of the process. See also French et al. (2007).

This chapter is organized as follows. First, we present a framework for a participatory process with MCDA tools and web-based participation. Then, we describe the lake regulation projects and evaluate the applicability of the framework against the experiences obtained from these projects. Finally, we give the concluding remarks.

12.2 Framework for a Participatory Process with MCDA Tools and Web-Based Participation

Figure 12.1 presents our framework for applying web-based participation and MCDA tools in participatory processes along with traditional methods. The two key features of this framework are as follows: (1) a steering group representing different interest groups and (2) active involvement of the public in the process. The

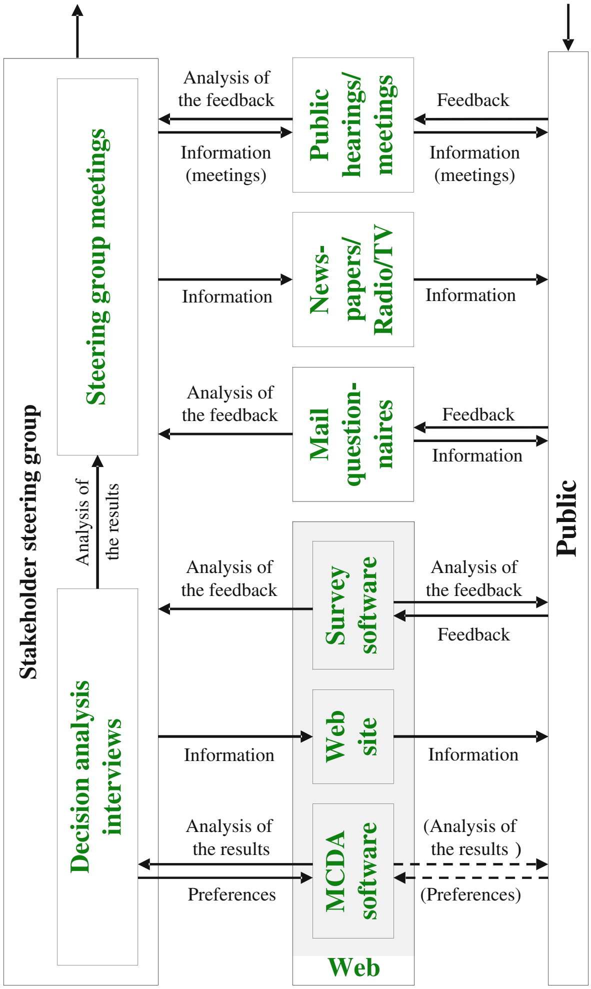

Fig. 12.1 A framework for the use of the web in participatory processes

steering group works collaboratively under the facilitation of experts in MCDA and environmental management. The aim is to get a shared understanding of the planning situation and, if possible, to find a joint solution. MCDA methods are used to systematically structure and identify the problem, objectives and alternative policy options, and elicit the group members' preferences in a common framework. The preference models are then collaboratively analyzed within the steering group to achieve a common understanding of other stakeholders' objectives. As a result of the steering group work, we get planning policy recommendations, which are still exposed for the public to evaluate.

Traditionally, the public has been involved in the process by organizing public meetings and hearings as well as by carrying out questionnaires and interviews in different phases of the project. The introduction of the Internet has provided new opportunities to carry out these tasks through the web. Generally, the web-based approaches are very cheap and cost-efficient, but with respect to some other objectives of participation, they may not be as efficient as traditional approaches. We shall discuss what are the benefits and possible problems of applying web-based participation instead of or in parallel with traditional approaches.

Morgan (1998) divides the participatory methods into four categories: (i) methods primarily for seeking public input, (ii) methods primarily for informing and educating, (iii) methods for promoting information exchange and interaction, and (iv) methods that aim specifically at finding commonly agreed solutions. Of the methods applied in our framework, web pages, newspapers, and radio/TV are initially designed for distributing information, whereas public hearings, survey software and mail questionnaires are mainly for collecting information. However, this categorization is not very strict; for example, with a mail questionnaire, it is also possible to efficiently distribute information to a focused group of people. The methods applied within the steering group (i.e. decision analysis interviews and steering group work) are interactive events, in which the information is exchanged and knowledge among the participants deepened. In public meetings, there is also some interaction between participants, but mainly they are intended for educating and seeking information from the public.

12.2.1 Multi-criteria Decision Analysis

The core of the framework is an MCDA process applied within the steering group. MCDA provides a way to model preferences of the individual stakeholders and analyze these in a common framework. The process is led by experts in decision analysis, who take care that all the different views are fairly brought out in the discussions and analyses. Figure 12.2 presents a course of a typical participation process in environmental planning and the use of different methods in different phases of the process. These phases are not, however, strict, as the process is typically an iterative one. For insights of carrying out the MCDA process, see, for example, Belton and Stewart (2002), French et al. (2009), Keeney (1992) or von Winterfeldt and Edwards (1986).

Multi-attribute value tree theory (MAVT) is an MCDA approach, in which the problem is constructed into a form of a value tree consisting of the objectives and measurable attributes. The alternatives are evaluated with respect to each attribute and the attributes are weighted according to their relative importance. Assuming that the attributes are mutually preferentially independent (see Keeney and Raiffa, 1976 or **French**), an additive value function can be used to obtain the overall values of the alternatives:

$$v(x) = \sum_{i=1}^{n} w_i v_i(x_i) \tag{1}$$

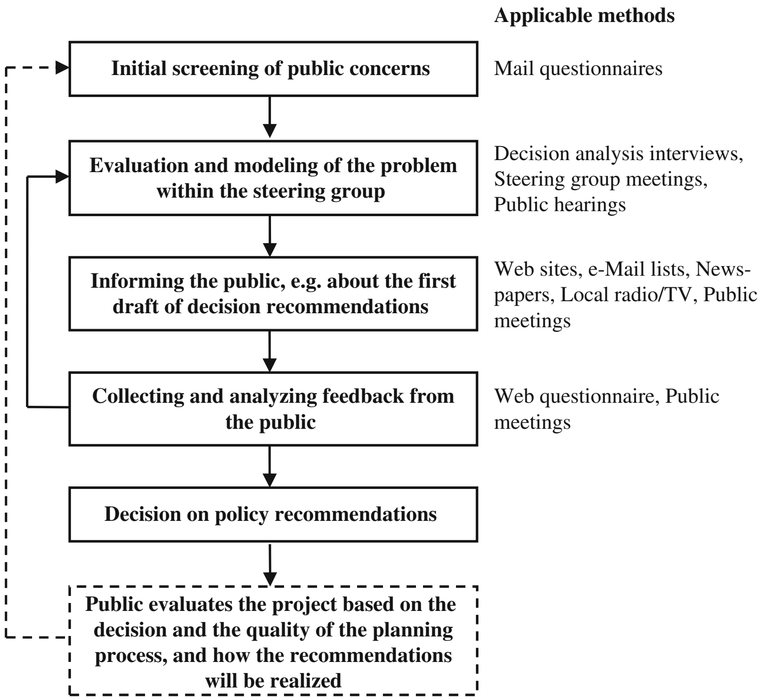

Fig. 12.2 A flowchart of the public participation process used in our cases

where n is the number of attributes, w_i the weight of attribute i, x_i the consequence of alternative x with respect to attribute i, and $v_i(x_i)$ its score on 0–1 scale. The 'swing' weight w_i indicates the relative impact of attribute i to the overall value, when the consequence of this attribute is changed from its worst level to its best level. In practice, there are different procedures to elicit the weights (see, e.g. Belton and Stewart, 2002; von Winterfeldt and Edwards, 1986). Sensitivity analyses can be carried out to study how the overall values change when varying the attribute weights or the consequences of the alternatives (see e.g. Belton and Stewart, 2002).

MAVT modelling is a delicate process and requires understanding of the methods. Thus, it is recommended to be carried out by an experienced decision analyst. There are different ways to use MAVT within steering group work. In decision analysis interviews (see e.g. Marttunen and Hämäläinen, 1995, 2008), the preferences of individual steering group members or stakeholders are elicited interactively with an assist of the decision analyst. He/she assures that the process is carried out properly and that all the different views are taken into account in the analysis. The obtained preference models are collectively analyzed within the steering group to get a view of the other stakeholders' preferences. The results of the preference models can also be demonstrated in public meetings to illustrate the differences between the stakeholder groups to the public. Another way to use MAVT is in decision conferences or workshops (see e.g. French, 1996; Phillips, 1984; Phillips and Phillips, 1993). These are 1–3-day events where the problem is collectively modeled under the facilitation of a decision analyst. The obtained common value tree can be weighted individually by the participants, and the results can be collectively analyzed to get a view of the other participants' preferences (see e.g. Mustajoki et al., 2007). See **Efremov and Ríos Insua** for additional details.

12.2.2 Tools to Communicate Through the Internet

There are different tools available for web-based communication. Plain web pages are applicable for information distribution, but for surveys and MCDA modelling some sophisticated tools are needed. In our projects, we have applied tools developed in the Systems Analysis Laboratory, Helsinki University of Technology. The two main tools have been Opinions-Online (Hämäläinen and Kalenius, 1999) for interactive surveys and Web-HIPRE (Hämäläinen and Mustajoki, 1998; Mustajoki and Hämäläinen, 2000) for MCDA modelling. Both are available on the Decisionarium web site for global decision support (www.decisionarium.tkk.fi; Hämäläinen, 2000, 2003), which also provides several other interactive tools for decision support, group collaboration, and negotiation.

12.2.2.1 Opinions-Online

Opinions-Online (Fig. 12.3) is a platform for global participation in forms of voting, surveys and group decisions (www.opinions.hut.fi). One can quickly create and edit questionnaires providing different ways of collecting data, such as multiple choice questions, approval voting, ranking of the alternatives and multi-attribute rating of the alternatives. Any text comments can also be collected. One can sample the opinions according to any set of the fields in the survey. This makes it possible to study, for example, the differences in the opinions between the stakeholder groups.

Opinions can be collected openly, restricted by domain or participant specific passwords. The creator of the survey can define whether the results are available online or only after closing the survey. One can also define whether the results are available for anyone or, for example, only for the creator of the survey. When personal registration is used, an opinion barometer can be used for interactive collaboration. Then, the entry is updated each time a new revised opinion is submitted. The variety of ways to analyze the results makes it possible to support different types of group processes, including the Delphi method. There is also a version of Opinions-Online (www.opinion.vote.hut.fi), which provides a set of advanced voting rules, where the results are derived from the ranking of the alternatives.

12.2.2.2 Web-HIPRE

Web-HIPRE (Fig. 12.4) is an MCDA software that supports both MAVT and the analytical hierarchy process (AHP) (Saaty, 1980, 1994; Salo and Hämäläinen,

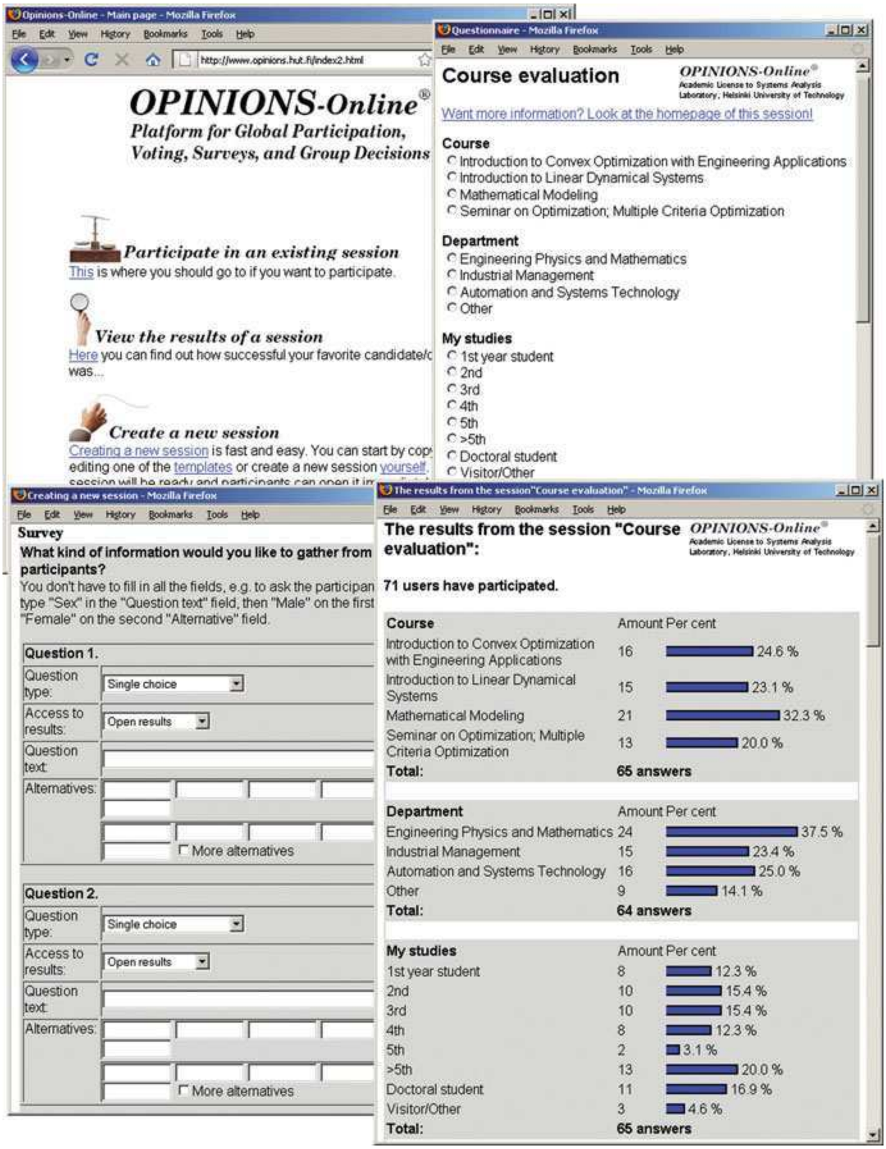

Fig. 12.3 An example questionnaire for course evaluation and analysis of the results in Opinions-Online

1997). It is a Java-based successor of HIPRE 3+ software (Hämäläinen and Lauri, 1995), and it is freely available on the web for academic purposes (www.hipre.hut.fi). The models created with Web-HIPRE can be saved on a server to a public or personal password-protected directory. It is also possible to import HIPRE 3+ models to Web-HIPRE.

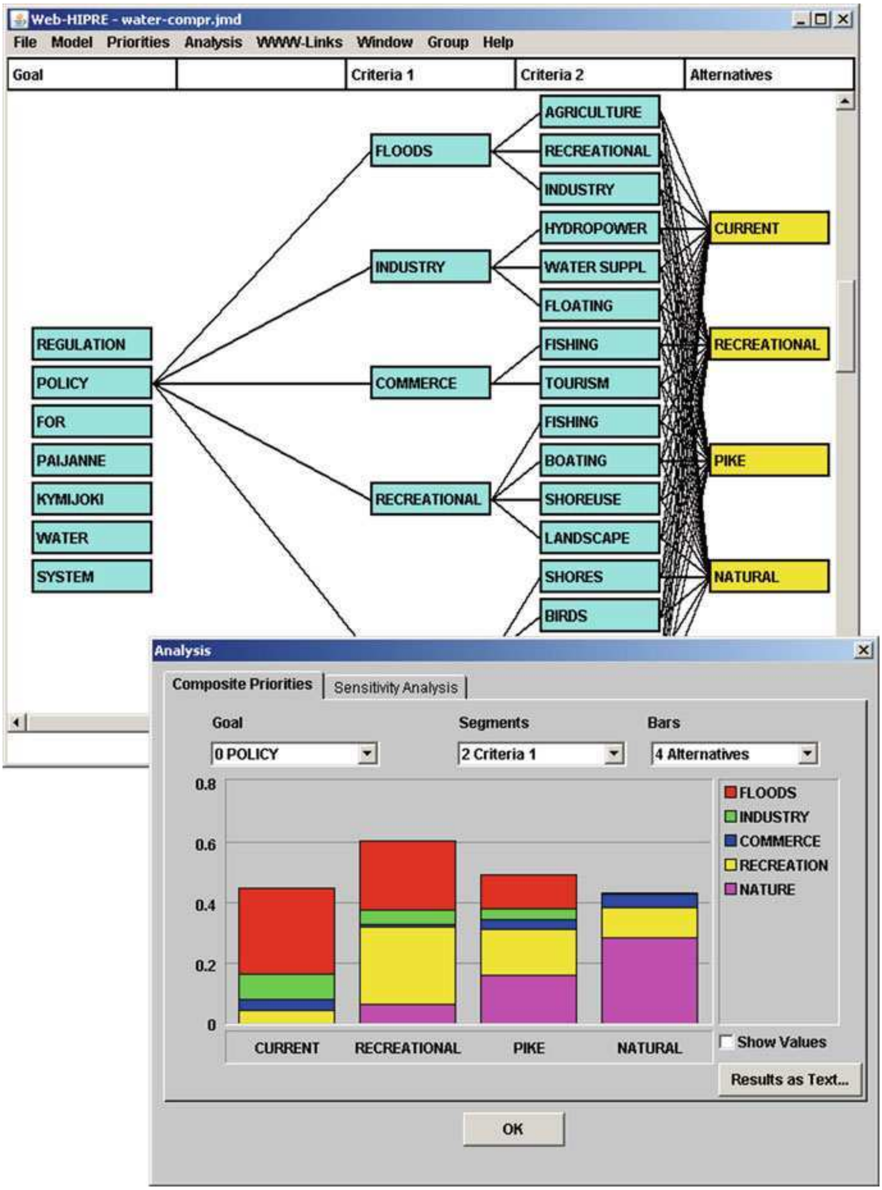

Fig. 12.4 Value tree and an example of overall values in the Lake Päijänne case

The interface of Web-HIPRE provides a visual approach to model the problem and analyze the results. The overall values can be divided into components indicating the influence of different criteria. Single parameter sensitivity analyses can be carried out to study the effects of possible changes in the criteria weights and in the values of the alternatives.

Of the MAVT weighting methods, Web-HIPRE supports SMART, SWING, SMARTER, and value functions (see e.g. von Winterfeldt and Edwards, 1986). Different methods can be used in parallel, which allows the easy comparison of the results obtained by different methods. It is also possible to convert normalized AHP weights into a 0–1 value scale to make these compatible with the results of MAVT methods. Alternatively, MAVT scores can be normalized to AHP weights.

Web-HIPRE can be used to support group decision making by simply using it as a collaboration platform. In addition, Web-HIPRE allows the aggregation of individual preferences in the group preferences with the weighted arithmetic mean method (Keeney and Raiffa, 1976; Ramanathan and Ganesh, 1994; Salo, 1995). One should, however, note that in general this requires the explicit comparison of interpersonal preferences (Keeney and Raiffa, 1976; Salo, 1995), which may not be straightforward. See **Efremov and Ríos Insua** for further details.

12.3 Evaluation of the Framework

We evaluate the applicability of the proposed framework (Fig. 12.1) to support participatory processes by discussing how well it meets the objectives of participation. The discussion is based on our experiences of the lake regulation projects and on the feedback received from the participants during the projects.

12.3.1 Lake Regulation Projects

The experiences are collected from four large lake regulation projects on Lake Päijänne, Lake Kallavesi-Unnukka, Pirkanmaa lakes and Lake Koitere (see Table 12.1). The projects are not described in detail but the focus is on studying different ways of involving the public and the stakeholders. In particular, the requirements for the use of web-based tools to support participatory planning in these types of projects are studied.

The majority of Finnish large water courses are regulated with the main objectives being flood prevention and hydro power production. Most regulation projects were started during the 1950s and early 1960s without any major environmental impact assessment. Since then, the use of water courses has changed. For example, the recreational use of water courses has grown considerably. Increased environmental awareness has also changed the values of the society and the attitudes of water course users. As a result, there has been pressure to update the old water level regulation projects. At the same time, the opportunities to diminish harmful impacts of regulation have also improved as the knowledge of ecological impacts has advanced.

The core of the participatory process was basically the same in all these projects and followed the process flowchart presented in Fig. 12.2. That is, public concerns were initially screened by a mail questionnaire, and the preference modelling and

Table 12.1 The lake regulation projects

	Päijänne	Kallavesi-Unnukka	Pirkanmaa lakes	Koitere
Years	1995–1999	1999–2001	2000–2003	2004–2006
Steering group	22 members 13 meetings 20 decision analysis interviews	20 members 6 meetings	40 members 7 meetings 36 decision analysis interviews	18 members 11 meetings 15 decision analysis interviews
Initial screening	Mail questionnaire – Sample 2,511 – Response rate 79%	Mail questionnaire – Sample 387 – Response rate 39%	Mail questionnaire – Sample 3,216 – Response rate 36%	Mail questionnaire – Sample 235 – Response rate 60%
Workshops and public meetings	10 public meetings 24 working group meetings – included interactive DA session	7 public meetings – 84 participants	6 workshops	3 public meetings
Feedback	Questionnaire in the closing seminar – 51 replies		Opinions-online primary way for public feedback – 333 replies on the web, 6 by mail	
Other special characteristics	Typical Web-HIPRE models available on the web	Opinions-online an alternative to mail questionnaire – 28 replies		Web actively used for information distribution

evaluation process were carried out in collaboration with a steering group. The public was involved in the process by arranging public meetings and hearings, and by carrying out questionnaires at different process stages.

In the use of MCDA methods, there were differences between the projects. In the Päijänne case, the preferences of the steering group members were modeled with MAVT by using HIPRE in decision analysis interviews (Mustajoki et al., 2004) (Fig. 12.4). The results of these analyses and draft recommendations were presented in the closing workshop to illustrate differing opinions of stakeholders (Marttunen and Hämäläinen, 2008). In the Pirkanmaa and Koitere cases, an MCDA-based Excel spreadsheet model was developed to create and study target regulations for the representatives of the steering group (Marttunen and Suomalainen, 2005).

We also tested different ways to involve the public through the web. In the Päijänne case, the example preference models obtained in the decision analysis interviews were made available in Web-HIPRE for the public to analyze. These were mainly used to demonstrate the opportunities of new technology (see Mustajoki et al., 2004). This case was also an example to test the opportunities of using web-based interactive negotiation support (see Hämäläinen et al., 2001). In the Kallavesi-Unnukka case, the initial questionnaire was sent by mail to randomly selected stakeholders but it was also available on the web for other stakeholders. The results of both the mail and web questionnaire were published on the web.

In the Pirkanmaa case, a web questionnaire was a primary way to collect public opinions before making the final policy recommendations. Suggestions for the recommendations and the reasoning behind these were described on the web pages, and Opinions-Online was used to collect public feedback on them (Fig. 12.5). The

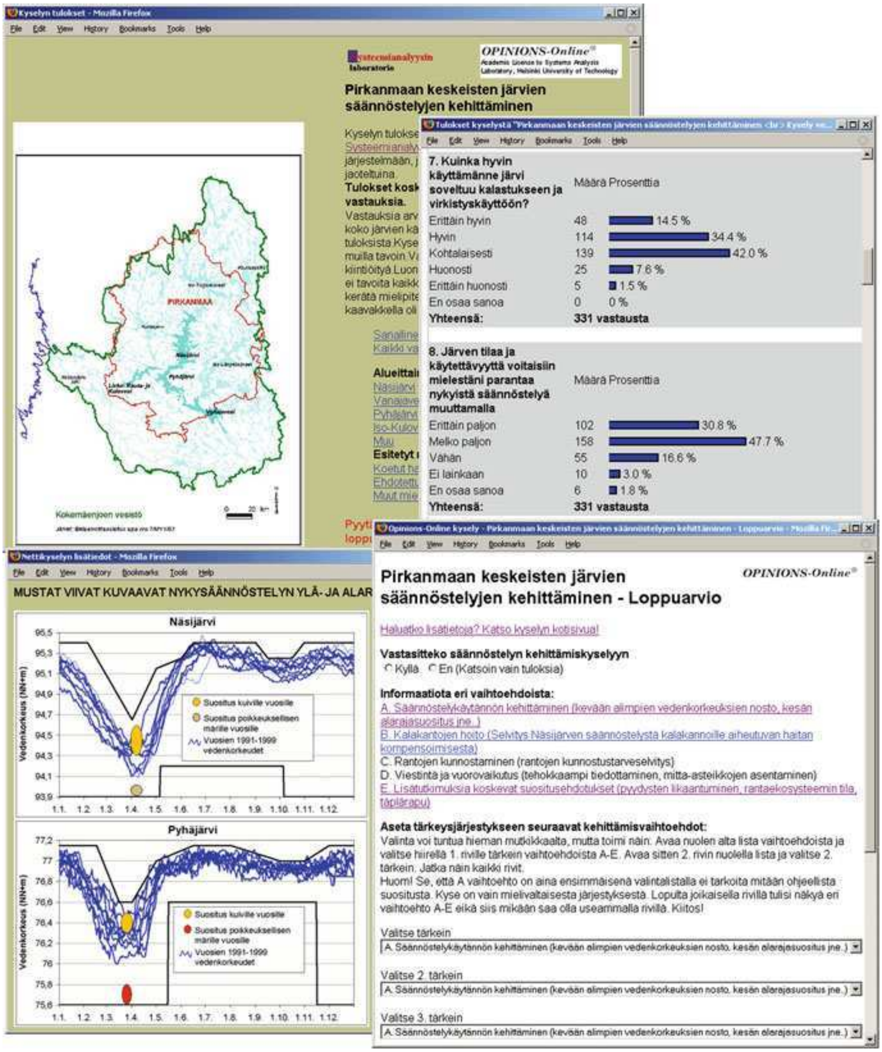

Fig. 12.5 Web pages demonstrating the collection of the stakeholder opinions and the communication of the results in the case of Pirkanmaa lakes (in Finnish)

possibility to reply on the web was extensively advertised in the major local newspapers, and on local radio and local television. In addition, information about the web questionnaire was submitted to various *e*-mail lists of different stakeholder groups (e.g. steering group members and representatives of local boating clubs) with a request to pass on this information to other stakeholders. The questionnaire was also advertised, for example, on the web sites of the local environmental institute, and of the fishermen. An alternative way to participate was to return the mail questionnaire available by request by phone from environmental institutes, but the use of the web was recommended.

12.3.2 Applicability of the Framework in Environmental Planning

The objectives applied to evaluate the framework are adapted from Beierle (1998). We have slightly modified the original objectives to better suit in our purposes. The evaluation is based on our experiences, and it is only tentative, as it is very difficult to evaluate different methods due to the lack of easily measurable performance indicators. One should also note that we have evaluated single actions alone, but these may have synergies when applied together with other actions. The results are collected in Table 12.2.

12.3.2.1 Informing and Educating the Public

In participatory projects, the first task is to inform the public about the existence of the project itself. Traditionally, this has been carried out by newsletters, or through general communication channels such as newspapers, the television and the radio. These approaches have the potential to reach a wider public and make people aware of the opportunities related to active participation. The web provides an easy additional way to support traditional approaches, as there are various portals that can serve as general information channels. Through these we can reach especially young people, who usually are not as active participants as elder people. Within organizations, the members can also be directly informed through *e*-mail lists. However, at the moment, we cannot only rely on Internet-based approaches, as these cannot be assumed to reach the public at large. For example, in the Pirkanmaa case we asked in which way the public received information about the web questionnaire. The majority of the respondents (55%) named newspapers as their information source, whereas 11% of the respondents received information from an *e*-mail list, 25% from their friends, and 5% found it by accident. The spread of response supports using several different methods in parallel to comprehensively inform the stakeholders. However, the large share of the latter two sources also suggests that in spite of the extensive publicity campaign on *e*-Mail lists and web pages, and on local newspapers, radio and TV, we cannot still assume that all local citizens and stakeholders knew about the questionnaire. This view also came up in the participants' written comments. This is primarily a problem for the traditional media, but naturally concerns web-based participation, too.

Table 12.2 Tentative effectiveness of the public involvement methods used in our cases to achieve objectives of participation. Assessment scale is from very low to very high, and the evaluation is based on our experiences

	Obj. 1a Informing	Obj. 1b Educating	Obj. 2 Public values	Obj. 3 Decision quality	Obj. 4 Trust building	Obj. 5 Conflict reduction	Obj. 6 Cost-effectiveness
Methods primarily to seek public input							
Mail questionnaire	High	Low	High	Moderate	High	Low	Moderate
Web questionnaire	Low	Moderate	High	Moderate	Moderate	Low	High
Public hearing	Low	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Methods primarily to inform the public							
Web site	Low	Moderate	Very low	Very low	Moderate	Very low	Very high
Newspaper	Very high	Low	Very low	Very low	Low	Very low	Very high
e-Mail list	Moderate	Low	Very low	Very low	Moderate	Very low	Very high
Local radio/TV	High	Low	Very low	Very low	Low	Very low	High
Methods to promote information exchange, interaction and learning							
Public meeting	Low	High	High	High	High	High	High
Decision analysis interviews	Very low	Very high	Very high	High	High	Very high	High
Stakeholder working group (steering group)	Very low	Very high	Very high	Very high	Very high	Very high	High

Obj. 1a. Effectiveness to distribute information to different user groups.
Obj. 1b. Effectiveness to foster participants' learning and understanding on the planning situation.
Obj. 2. Effectiveness to find out public/stakeholders' opinions.
Obj. 3. Effectiveness to incorporate the public/stakeholders' opinions into the planning process and to generate new ideas and insights.
Obj. 4. Impact on the public/stakeholders' confidence to the process.
Obj. 5. Impact on reduction of the opposition toward the decision.
Obj. 6. The performance of the method in other objectives with respect to its cost.

Once the public has been informed about the project and its web site, the web provides an efficient way to distribute information. Thus, the public should be informed as early as possible, for example, by starting the project with an extensive newsletter, *e*-mail and web bulletin campaign directed to all the possible stakeholders or citizens in the impact area. In this newsletter, the public can also be asked to join an *e*-mail list providing information about the events of the project. This is especially important in long-term projects where interaction with the public is infrequent, and there is a risk that the public may lose interest in visiting the project web pages.

In educating the public, our studies brought up a question of how the public should be educated through the web. Understanding of the other stakeholders' views is a key to a successful participatory process and, thus, the stakeholders should have adequate knowledge about each other's views. However, in our cases, the education through the web did not happen as was planned. For example, in the Pirkanmaa web questionnaire, the public was asked to independently study the material on the links regarding the recommendations, before they gave their opinion on them (Fig. 12.5). However, only one tenth of the respondents visited all the material and almost one fourth of them did not visit any material. Thus, we cannot assume that all the stakeholders had the necessary knowledge to be able to carefully consider, for example, the question about the fairness of the suggested recommendations. In this respect, web-based participation may be considered even too easy, as the public may purposefully or unconsciously neglect some viewpoints. In contrast, for example, in public meetings, the audience is 'forced' to listen and consider the issues from different viewpoints. The challenge is also to get the public learn web-based material with commitment.

12.3.2.2 Incorporating Public Values and Knowledge in the Process

In our cases, the most efficient methods for incorporating public values into the planning process were stakeholder steering groups, public meetings and workshops, and decision analysis interviews. One should, however, note that an important factor in making these methods efficient was that the steering group members and decision analysis interviewees were carefully selected to represent a wide variety of the stakeholders, and consequently a wide variety of opinions.

In each of our cases, we used mail questionnaires to survey general opinions among the public. In the Pirkanmaa case, we also tested allowing the public to give their opinions about preliminary action recommendations over the web. However, only 333 stakeholders responded to this survey, although the total number of people who knew about the survey can be estimated to be several thousands. On the other hand, the response rates in mail questionnaires were very high. For example, in the initial questionnaire of the Päijänne case it was 79%. We think that one reason for the difference in response rates was that directly sent mail makes the stakeholder feel that his/her particular opinion is important. This can consequently increase his/her willingness to reply, whereas web-based approaches are not considered very personal. Nevertheless, with respect to incorporating public values in the process, we think that the amount of response in the web questionnaire was sufficient to elicit even the most extreme views of general public. However, to make the participants feel that their opinions were appreciated, we think that mail and web questionnaires should be used in parallel to provide all the interested stakeholders a possibility to take part in the decision-making process.

With web-based MCDA software, anyone could also be allowed to independently create her preference models, as the software does not require any installation and is available at any time. However, the use of MCDA methods requires understanding of decision modelling, and there is a high risk of biased results if the theory behind the method is inadequately understood (see e.g. Pöyhönen and Hämäläinen, 2001; Weber and Borcherding, 1993). Consequently, this could decrease the participants' trust and commitment to the obtained results. Thus, a totally independent use of decision analytical software may only be suitable for experienced users. Yet, an intermediate way is to allow the public analyze the preference models of the steering group members with an aim to increase understanding of different stakeholder groups' preferences. However, this mode also requires some understanding of the methods, and may thus not be generally applicable.

With web-based MCDA software, it is also possible to carry out remote decision analysis interviews, in which the interviewee uses the software according to the decision analyst's guidance given through the web. However, this approach may not be very applicable either, as in face-to-face interviews the decision analyst is likely to better observe the possible hesitation in the use of the method (Marttunen and Suomalainen, 2005). Thus, the presence of the decision analyst is often needed. However, more research is needed on this issue to study the applicability of, for example, video conferencing equipment.

The group model facility of Web-HIPRE can be applied to combine the results of individual models under a common group model. It can be useful, for example, in a decision conference arranged in a few different places simultaneously through video conferencing. One should, however, note that the issues related to the independent use of the software also apply here.

As one way of meeting the challenge of independent use of advanced multicriteria software, we have developed web-based material for learning the use of the methods and software (Hämäläinen, 2002). This material includes illustrative tutorials and example cases demonstrating, for example, how to avoid the possible biases. Nevertheless, in this approach the participants' commitment to learn the material is also essential, and more research is needed, for example, on how devotedly the public would go through this material in real cases. However, for example, in facilitator training this kind of material is likely to be more useful, as facilitator trainees are more motivated to learn the material as the general public.

Another way to enhance the independent use of MCDA software is to develop methods and software that does not require mathematical or decision analytical background to use the method. For example, even swaps (Hammond et al., 1998, 1999) is a conceptually simple method intended for the general audience. In even swaps, the user does not have to explicitly define the preferences over the attributes in general, but the most preferred alternative is found out through making tradeoff like swaps on the values of alternatives. The related Smart-Swaps software

(Hämäläinen et al., 2003; Mustajoki and Hämäläinen, 2007) can be applied to help the user to consistently carry out the process in practice. On the other hand, the interpretation of the results of the even swaps process is not as transparent as in traditional approaches. More research is needed to study the independent use of this kind of software, as well.

12.3.2.3 Decision Quality and Conflict Reduction

In our studies, the steering group work supported with multi-criteria decision analysis interviews provided a convenient way to clarify the facts and values of different stakeholder groups and, consequently, to improve the substantive quality of decisions. The studies showed that the general understanding of the problem can be increased by clearly interpreting the results of the MCDA models to the stakeholders. In the Päijänne case, the preferences of different stakeholder groups obtained with HIPRE models were used as a ground for developing new regulation policy alternatives. With these, it was possible to show how different views people had even within single stakeholder groups before the consensus seeking phase of the project. The results suggest that the participants' understanding of the difficulty of the process is likely to have improved. The applied methods were also effective ways in reducing conflicts among the members of the steering group through understanding the other stakeholders' preferences. For example, 80% of the respondents agreed or partly agreed that the recommendations for the regulation combined the different interests of the stakeholders. The steering group as well as workshops and decision analysis interviews appeared to be good arenas for discussion, reflection and learning.

In the Pirkanmaa case, the corresponding evaluation of the regulation recommendations was carried out independently on the web. However, only 35% of respondents agreed or partly agreed that the recommendations combined the different interests, although the process and the recommendations were quite similar as in the Päijänne case. We think that one reason for the low approval rate was that, on the web, the stakeholders had to independently study the material but it was not demonstrated to them as would have been done in a public meeting. Most of the respondents neglected to study some of the material of the impacts, and thus, they may not have been able to analytically consider the other stakeholders' opinions. One should, however, note that in the Päijänne case approximately 30% of the respondents were representatives of the steering group which may partly explain the differences in the stakeholder satisfaction between the cases.

12.3.2.4 Building Trust

In building trust, it is very important that the process itself is transparent and that the public is informed of what is going on in the process and within the steering group (Beierle and Konisky, 2000; Slovic, 1997). At the start of each of our projects, there was some mistrust and contradiction between stakeholders. However, the use of several complementary methods enabled involving the stakeholders and citizens with their knowledge, values, and hopes in the different phases of the process.

In our cases, the steering group had an important role in building trust. In this respect, it was important that the processes lasted 3–4 years allowing the steering group members enough time to get acquainted to set aside stereotypes and misperceptions. The stakeholders also had an opportunity to affect, for example, the types of studies carried out, the description of impacts and their importance and the presentation of recommendations. This signaled to the stakeholders that their opinions are appreciated, which can be important in increasing trust toward the neutrality of the projects.

The web provided a convenient way to put material of the projects available for the public to access it anytime and anywhere. We do not have data about the visits on this material, but we think that even an awareness that there is material available on the web, is likely to increase the transparency of the projects and consequently, the stakeholders' trust in the process.

In the Päijänne case, we demonstrated an opportunity to allow the public to analyze Web-HIPRE models on the web. However, this was not widely advertised among the stakeholders and remains as a subject of further research. It would be interesting to study, for example, if better knowledge about the techniques and tools could have positive impacts on how people consider the project. Nevertheless, even if the public did not analyze these models, putting these available could increase transparency of the process.

12.3.2.5 Cost-Effectiveness

In general, we think that all the methods considered in our cases are cost-effective ways to carry out the task for which they were intended. The utilization rate of web-based material and the response rate of web questionnaires are typically low, but these approaches are so easy and cheap to implement that they are worth using. Decision analysis interviews and the work with the steering group are expensive and laborious to carry out, but the advantages of these approaches in eliciting and analyzing the different views of the stakeholders are substantial. Mail questionnaires are also quite expensive, but the high response rates of them make them very useful. With them it is also possible to inform the public about the projects.

12.3.3 How to Attract the People?

Our cases demonstrated that web provides an applicable additional way to allow the public to participate. However, the cases also showed that web-based participation only attracts a limited number of people. We think that one of the main reasons is that, although the public is heard, they often feel that their opinions are not taken into account in the planning process. This also came up in many written comments during our projects. Therefore, it is important that people are informed of their real opportunities to affect the process. Furthermore, when the final results are disseminated, it is important to describe the effects of the input of the stakeholders and the public in the outcome, and the learning process that has happened in the steering group meetings. The challenge is, however, to understandably and effectively describe these to the public. One should also note that the feeling of being neglected can be a problem with the traditional ways of participating as well. However, in this respect, the web does not give any added value, as web-based participation can be considered even more voluntary than traditional approaches. Web-based approaches are not very personal, and they are often associated with entertaining purposes that do not require commitment to the process. Consequently, in serious issues the public may not consider the problem with full commitment.

The capacity and willingness of elderly people to use new technical innovations is not as good as with younger people, which is quite understandable. The low utilization rate of the web among the elder people was also reflected in our web questionnaire, as the response rate decreased strongly on age groups from 55 upwards, which did not happen in the initial mail questionnaire. On these age groups, speeding up the adaptation of the web is challenging as many people who do not currently use the web are not likely to start using it in the future, either. Thus, it will take another 10–20 years for a new generation of web users to grow up. On the other hand, the young people did not were active neither in mail nor web questionnaire. These people are used to the web, and thus we think that the reason for the low response rate was the lack of interest in societal issues in general. On these people, it is very important to make them realize that participation is an effective way to affect these issues. In this respect, web-based approaches may make them feel that they are also considered, and consequently, to make them more keen to participate.

12.4 Conclusions

In this chapter, we have described a framework for supporting participatory processes which includes tools for decision analysis and web-based support for participatory feedback. Our experiences obtained from the lake regulation applications support the applicability of the framework where the traditional approaches and web-based approaches are used in parallel. Especially, the intense and continuous interaction between stakeholders was considered very positive, which supports this kind of participation. However, creating a culture of web-based participation requires several case projects before the public stakeholders and the authorities can accept this new approach.

We think that close co-operation of decision analysis researchers, policy support administrators, experts and stakeholders is extremely important in the development and application of new approaches and tools. In this way, we can take the needs of all parties into account in the practical development of the approach. We consider this as a basis for creating a sustainable framework for public participation. We also emphasize that public meetings or workshops should be organized in a systematic way. The challenge is to link methodological experiments to a real-life planning situation, as it is not possible to work similarly with real stakeholder as, for example, with university students.

We believe that there are no shortcuts in speeding up the process, but the culture of web-based participation grows from positive case studies. The challenge is to create a new tradition for electronic democracy in which the public can have a true impact in important social matters. However, much of the success depends on how well and credibly the authorities can implement the modelling and analyze the results. In this respect, collaboration between decision analysis researchers and policy administrators is extremely important. Naturally, more research is needed on, for example, how the different ways of presenting information on the web affect the learning process of the public, and how the use of the web as a communications channel affects the commitment of the participants.

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Chapter 13
A Generic System for Remote *e*-Voting Management

Carlos Grima and David Ríos Insua

13.1 Introduction

We view *e*-government as a government system at any level (local, state, supranational, etc.), in which most of the administrative and political activities are computerized and can be undertaken entirely using Internet. These activities include, for example, tax payments, enrolment in a school, debating, voting, etc. An *e*-democracy would be a type of *e*-Government inspired by democratic principles, see **Arenilla**. In it, voting is one of the most relevant activities, see **Nurmi**. Thus, it deserves careful attention. In fact, most of the criticisms usually mentioned about *e*-government and *e*-democracy refer to the apparent lack of security and reliability of electronic voting systems. **Nurmi** provides a comprehensive review of the theory and methods of voting. A good overview of recent developments in electronic voting may be seen in Krimmer and Grimm (2008).

In this chapter, we shall outline the design of a generic computer system for electronic voting through Internet, with as general a set of requirements as possible. For that, we use the UML language (Booch et al., 2006) and follow the most important recommendations of the ANSI/IEEE 830-1998 standard for describing software system requirements (ANSI, 1998). In particular, we include its behaviour and functionality using UML use cases, clustered around our system goals. As an example, we detail some of these use cases, using a textual template (Duran et al., 1999) and a UML communication diagram. This will provide details about the message traffic between the corresponding system classes. As for the static part, the system depends only on a database that contains all the necessary information: participants, voting, votes, candidates, etc. Its structure is described through an extended entity-relationship diagram (Thalheim, 2000), from which we easily deduce the analysis level class diagram of the system (Booch et al., 2006). We will do this in the context of a generic architecture to build computer systems that support *e*-government as in (Grima-Izquierdo and Ríos Insua, 2008).

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13.2 *e*-Voting Experiences

Prior to the first experiences in electronic voting, many electoral processes in the world already relied on computer technology to count votes and transmit data. This computerization allowed us to know the election final results a few hours after polling stations closed.

In recent times, several nations and organizations have begun to go beyond, trying also to computerise vote collection. We call this electronic voting. There are two major groups of electronic voting systems: physical and remote. In the first, the voter must go to a traditional polling place and vote there using a special machine based on touch screens, keyboards, etc. In remote systems, we use a communication network, typically the Internet, to send the vote from the place where the voter stays (say from his home) to a virtual urn, which is the type of computer system described in this paper. It is desirable that the device where the voter stays (possibly, his own personal computer) is not controlled by the virtual urn system, as the Council of Europe recommends to European Union members when establishing standards for legal, operational and technical aspects of computerized voting, whether physical or remote (Council of Europe, 2009).

Initially, electronic voting was used in connection with private voting, especially in the context of enterprises or associations. Large companies have made many efforts in this direction, considering seriously the use of electronic voting to facilitate shareholder meetings. On the other hand, it is now habitual to vote remotely in professional associations such as the International Society for Bayesian Analysis, INFORMS, the American Statistical Association or the Society for Judgment and Decision Making. Lately, some public administrations started pilot experiences which have multiplied recently. Indeed there are many nations that have begun to study the introduction of some form of partial electronic voting to increase citizen participation in elections, facilitate the counting process, and to attempt to reduce electoral fraud and mitigate potential problems of illiteracy.

There were, and there are, many criticisms to electronic voting experiences. In Belgium, for example, there have been significant technical problems that caused scandals (Afront Society, 2004). However, they are not limited to this country in its commitment to the use of new technologies. Ireland (Bannister and Connolly, 2007), in view of evidences of insecurity in their electronic voting system opened in 2004 (Gonggrijp and Hengeveld, 2006), abandoned it, at least temporarily. In Venezuela, it is suspected that electronic voting has been used as a tool by the political group in power to perpetuate itself (Prado and Sansó, 2004). However, the most serious criticisms took place paradoxically in the USA, one of the most technologically advanced countries with a rooted democracy, because of the suspicion of large-scale electoral fraud. Indeed, there were important irregularities in the use of physical electronic voting machines in the presidential elections of 2000 (Presnell and Agresti, 2002; Palast, 2003) and 2004 (Kohno et al., 2004 and Card and Moretti, 2005).

Because of the mistrust and fear of novelty, increased further by the problems described above, most countries have chosen to use small-scale electronic voting in test mode, to observe the results obtained in terms of citizen satisfaction and potential use. Examples include Canada, Australia, Spain, Philippines, Japan, Australia, Germany, France, Sweden, Netherlands and the UK. However, other countries have a firm commitment with full implementation of electronic voting. Brazil was, in October 2002, the first country to implement physical electronic voting successfully without relevant criticisms (Rezende, 2004). It was used by 100% of voters in a general election. The first nation that implemented successfully a remote electronic voting in a general election was Estonia in 2007, after careful legal and technical assessment in previous years, as described in **Madise and Maaten**.

13.3 System Context

Our electronic voting system, especially its security, is based on problems and successes found in the above experiences. It is part of a larger computer system (Grima-Izquierdo and Ríos Insua, 2008) aimed at supporting entirely any *e*-government activity, with special emphasis in *e*-democracy. The actors (citizens, politicians, civil servants, political parties, enterprises, social organizations, etc.) connect with the system (server side) from anywhere (client side) using the Internet, to run an *e*-procedure, which is any administrative or political activity relating to public administration at any level. Examples of *e*-procedures would be those designed to pay taxes, to enrol a child in a school, or, as we discuss in this chapter, to vote in elections.

Note that, in the future, our system users (actors) might not always be humans. They may also be other computer systems, possibly endowed with some intelligence. This will be especially interesting in the case of a direct *e*-democracy, in which citizens could be called to vote in many occasions. To reduce the opportunity costs due to time lost by the citizens, perhaps in the future they optionally could have intelligent software agents (Brenner et al., 1998) at their service, of course under frequent human supervision. These agents are simple programs that run on the server side. They would learn the political preferences of its owner and would represent him accordingly, through voting, negotiating, ...

To achieve its purpose, the generic *e*-government system in which our voting system is included is divided into three main subsystems and two large databases (Fig. 13.1).

An actor logs in the system using the interface, which looks for him in the Census database. Once properly identified through appropriate security requirements, the actor searches and ask for an *e*-procedure execution. To do so, the interface communicates with the *e*-Procedure Control subsystem, which coordinates the execution of various *e*-procedure steps. Each of these steps, called *e*-services, is executed by an *e*-Agency, which is the computer implementation of a public administration. For this purpose, an *e*-Agency may need the Census again. All *e*-Agencies reside in an *e*-Agency Container. This allows us to add or remove *e*-procedures, e-Agencies and *e*-services, using a special *e*-Agency called the Computer Administration *e*-Agency. Finally, some *e*-services are executed by actors rather than *e*-Agencies, e.g. a civil servant electronically signing a document. In this last case, the *e*-Procedure Control

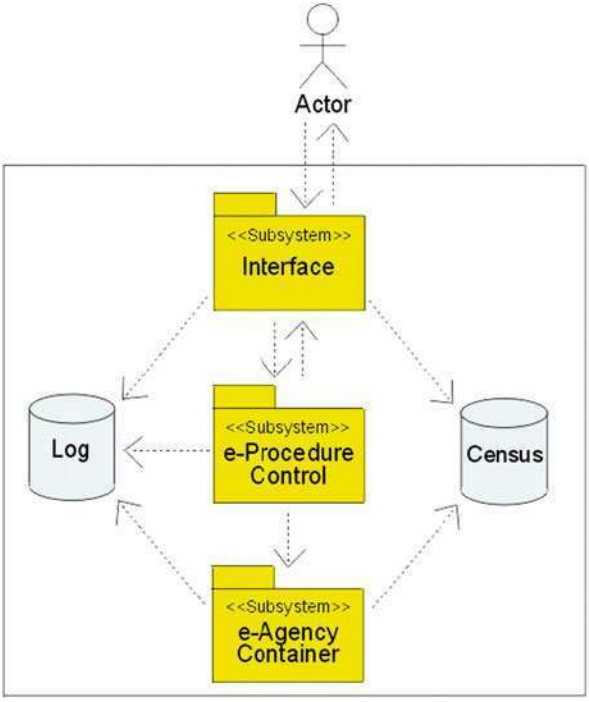

Fig. 13.1 General architecture of the *e*-government system

sends the request to the Interface, rather than to the *e*-Agency Container, in order to communicate with the relevant actor.

As we have mentioned, *e*-procedures consist of a set of *e*-services, not necessarily sequentially ordered, as there might be loops. From this point of view, an *e*-procedure can be viewed as a computer program executed by the *e*-Procedure Control. Each *e*-procedure has its own specifications for implementation, consultation, modification, security, etc. The system does not have a priori limitations to these conditions. This means, for example, that we could potentially have an *e*-procedure to vote that allows to be executed several times by the same actor in the same voting, to modify his already issued vote.

The system includes, inside, *e*-Agencies at all levels (local, regional, national, supranational, etc.), because there may be *e*-procedures involving *e*-Agencies and *e*-services from different levels. An example would be changing the city of residence. The appropriate *e*-procedure would communicate with the city council of origin (to unsubscribe there) and with the destination city (to register there). As we can see, the system could be used by millions of actors from all economic and cultural levels. We might think, for example, of the complexity of such system for the entire USA.

Our electronic voting system is within the so called ‘Decision Making *e*-Agency’, which supports any decision-making process (legislative, executive or judicial). Each decision may pass through one or more steps such as structuring and defining,

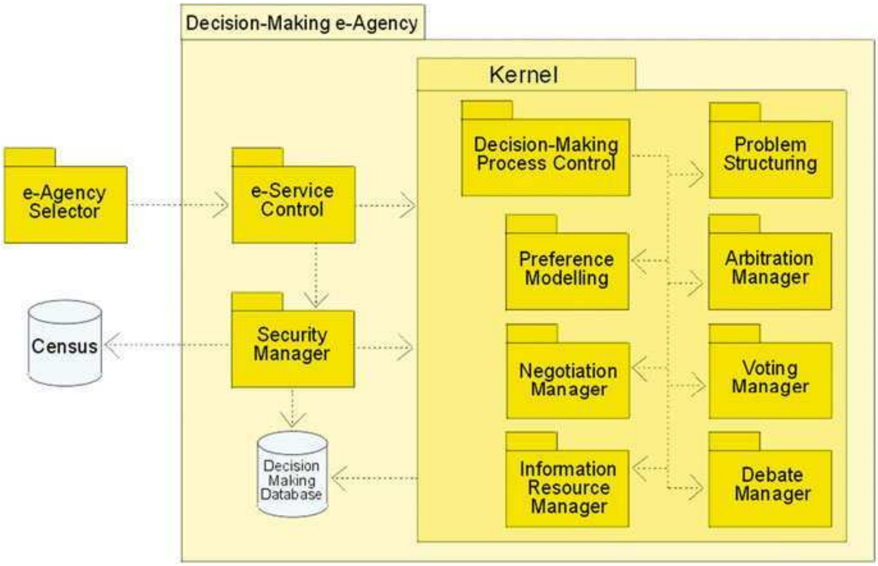

Fig. 13.2 General architecture of the decision-making *e*-agency

preference collection, debate, arbitration, negotiation or vote. Each of them has an associated subsystem within the *e*-Agency kernel. There is also another subsystem to coordinate all these steps as necessary called the Decision-Making Process Control. In Fig. 13.2 we describe the general architecture of this *e*-Agency, in which we appreciate the role of our electronic voting manager system.

13.4 General Description of the *e*-Voting System

We fulfil now some of the recommendations that the ANSI/IEEE 830-1998 mentions to properly describe software system requirements. We focus on discussing the goals, actors, interfaces and dependencies. Other major points of this standard will be dealt with later on more extensively.

The functions of the Electronic Voting Manager System are the following:

1. Execution of voting, allowing actors to vote and change their vote, should they will, before a deadline. Security restrictions, which are considered separately, establish under what conditions all these tasks can be carried out.
2. Management of voting: create them, delete, communicate its properties, view and modify their state, and so on.
3. Provision of information, about partial or final voting results, allowing not only to see overall statistics but also to check every single vote should security restrictions allow us.

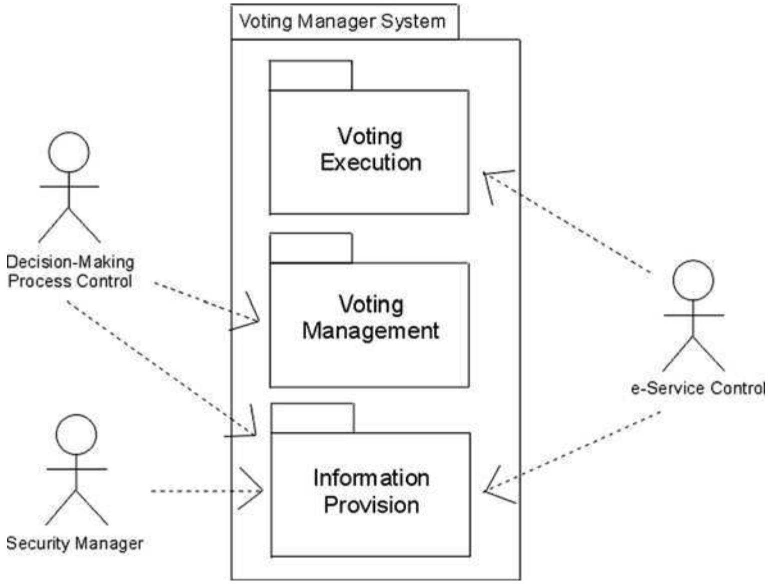

Fig. 13.3 Voting system functionalities according to goals and interactions with actors

As Fig. 13.3 shows, we may group all the system functionality according to these three goals. Therefore, we subdivide the system into three parts and provide UML use cases for each of them. Actors within this system will be the following: the Decision-Making Process Control, the *e*-Service Control and the Security Manager. Each actor interacts with the functionality belonging to one or more goals, as Fig. 13.3 shows. Note that, because the voting system is inside a wider global system, these three actors are subsystems from the last. Humans will manage the global system using *e*-procedures, which will give individual instructions to the three actors to interact directly with the Voting Manager.

Although this is a design requirement, we recommend the interface to be used by actors to be a set of "web services". We justify this decision by the fact that web services is already a standard, simple and well-known technology, and it allows the *e*-Agency to be a distributed system. Note that no graphical interface is necessary as actors are not human beings.

13.5 Security

Recall that the systems included in the *e*-Agency kernel do not have to be responsible for most of the security issues. The reason is that all security is centralized in a specific system (Security Manager), to which the *e*-Service Control refers for permission every time it requires the use of the kernel. Thus, the Voting Manager system will not have to be responsible for, e.g., checking whether someone is voting in an election in which he can actually participate, or if the voting session is still open or if someone tries to view or modify a vote owned by another participant.

For this security scheme to work properly in a distributed environment, the only requirement would be that each member subsystem verifies that all requests come only from those that depend on this subsystem. In the case of our Voting Manager, it would ensure that each call to any of its web services comes from one of the three actors described above. Otherwise, it would ignore the request.

Each system within the *e*-Agency keeps a log of all its activities. Periodically, the *e*-Agency Selector will ask the *e*-Service Control for a unified log of all its subsystems. To do so, the *e*-Service Control will get the individual logs from each module. Our Voting Manager will not be an exception. Therefore, it will record in its temporal log a trace of all its activities, including those requests that do not come from its three actors, in order to deliver them, when requested by the *e*-Service Control.

In a more generic and comprehensive way, there are many security issues related to the actual implementation of *e*-government systems (Grima-Izquierdo and Ríos Insua, 2010), and, therefore, that directly affects electronic voting. See (Bannister and Connolly, 2007) for additional discussion.

Some of the most important problems and possible solutions are as follows:

- The system must be available, especially during voting time. This could be ensured by replicating the system at several places so that if one of the replicas fails for any reason, the others can continue providing the service (Castro and Liskov 1999).
- To prevent fraud, the system should be watched in person by citizens, political parties, software engineers, lawyers, police, etc. However, the watchmen need to be watched. The obvious solution is monitoring each other and that, to avoid corruption, any citizen could check the system, as it happened in Estonia (**Madise and Maaten**). If we add that this verification can be performed at any time, even by surprise, we believe this issue is reasonably solved.
- Under the control of a malicious government, the system could collect sensitive data from actors, such as what each person voted. To ensure vote secrecy, one solution would be that actors use an identity masking, such as a nickname (nick). Only each person, and not the system, knows his own nick. Then, the system could only know and save what each nick voted, not the real person, as his name does not appear anywhere. Nicks are manually and randomly assigned from time to time, with no system intervention.
- To ensure that an actor has voted and what voted, the actor and the system should digitally sign a document specifying these details. This contract would be the proof of fact. Therefore, neither the actor nor the system could blame each other of fraud.
- To avoid somebody adding “ghost votes” and, therefore, manipulating the results, all accounts should be made public, including what each masked actor voted. These government statistics can and should be verified by political parties or independent candidates to ensure their validity.

- It is relatively easy to sell votes, if we only have to provide our nick and password to an eventual buyer. To complicate it further, a possible solution would be to require that the system associates a nick with biometric data (iris, fingerprint, etc.), so that the voter must enter it whenever he wants to vote. Alternatively, another verification may be based on using some hardly transferable mechanism based, e.g., on anonymous mobile phones.

For a comprehensive description of all these threats and their solutions, plus a complete risk analysis, see (Grima-Izquierdo and Ríos Insua, 2010).

13.6 Data Structure

The relevant information that our system must handle will be a subset of the Decision- Making Database. This subset is represented in the form of class diagram (Booch et al., 2006), in Fig. 13.4. The class diagram is an equivalent way of representing an extended entity-relationship diagram (Thalheim, 2000).

Albeit important, voting is just an instance of possible activities within a group decision-making process, see **Lavín and Ríos Insua** for further details. A decision problem can be formed by one or more decision activities, which will be executed in a certain order to reach a final decision. For example, one decision problem would be to approve the budget for the following fiscal year in a city council, see **Alfaro et al**. The first decision activity could be to debate the needs of the city; the second could be to debate the alternatives presented; the third could be to negotiate about them; the fourth, to vote if no agreement has been reached so far; the fifth, to renegotiate if the voting results are not satisfactory for the majority; and so on. Note that several voting sessions, with different options, might be necessary within the same decision problem.

A participant cannot vote more than once at each voting session, as suggested by the association between the classes 'Participant' and 'Voting'. A voter marks none (blank ballot) or multiple options (multiple vote) depending on the voting method.

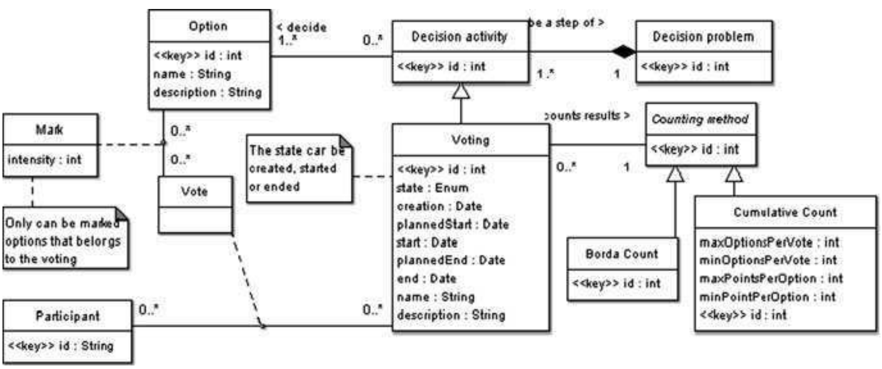

Fig. 13.4 Relevant data structure handled by the Voting Manager system

For each marked option, he assigns a 'mark intensity', which is converted into points according to the voting method, or deemed null if the set of mark intensities is inconsistent. Should we want to include other voting methods, we only need to add the appropriate new class, descending from the "Counting Method". In the diagram we have included Borda count and cumulative voting; see **Nurmi**. The winner will be the option with the biggest number of points.

13.7 Functional Requirements

Several recent catalogues (see, e.g., Volkamer and McGaley, 2007), have described textually requirements for general voting machines. Note that our system is intended for remote electronic voting. It is not our goal here to make a new comprehensive textual catalog. Instead, we will state the main use cases, which is a more modern way to describe requirements, and we detail three of them as examples.

Each use case belongs to one of the three parts (packages) in which we have divided our voting system. Recall (Fig. 13.3) that each of these parties agrees with each of the three main system goals, which are voting execution, voting management and information provision.

13.7.1 Use Cases in the 'Voting Execution' Package

The use cases are (Fig. 13.5):

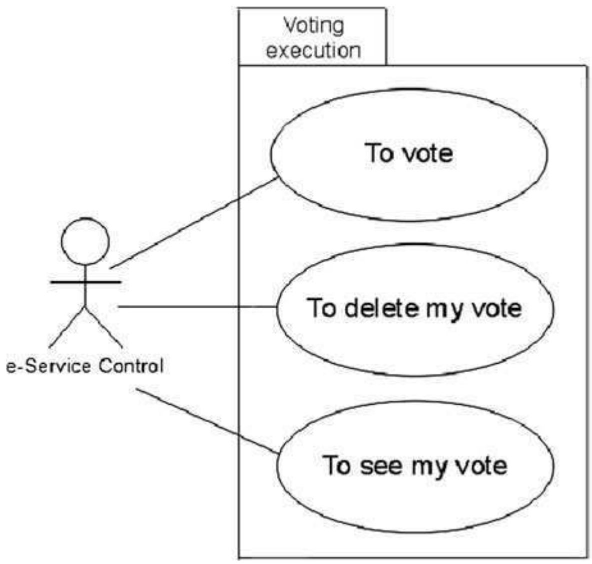

Fig. 13.5 Use cases in the 'Voting execution' package

- To vote (UC-1). It allows the participant to vote in a running voting session. Should he have voted already, his vote would be replaced by the new one.
- To delete my vote (UC-2). It allows a participant to delete his previous vote in a running voting session.
- To see my vote (UC-3). It allows a participant to see his vote in a voting session.

As an example, we shall describe the use cases within the package 'Voting execution' using two standard techniques: a textual template with all scenarios following (Durán et al., 1999) methodology and a communication diagram (Booch et al., 2006) of the most important scenario of the use case, to describe in detail the message traffic through the architecture.

13.7.1.1 Use Case 'To Vote'

A textual description of the main scenarios within the use case 'To Vote' is provided in Table 13.1.

Table 13.1 Textual description of the use case 'To vote'

UC-1	To vote	
Associated goals	To execute voting	
Short description	A participant can vote in an open voting session. If he has voted previously, the old vote is replaced by the new one	
Preconditions	The voting session must be open	
Normal scenario	*Step*	*Action*
	P_1	The actor initiates the use case, sending the following information to the system: • Participant identifier • Voting identifier • List of marked options. It is the list of pairs: (<option identifier>, <mark intensity>)
	P_2	The system records, for that voting, the pair (participant identifier, vote)
	P_3	The system informs the actor that the vote of participant <participant identifier> has been successfully registered
Postconditions	The participant is registered as having voted	
Exceptions	*Step*	*Action*
	P_1	If the voting identifier does not exist, the system informs the actor. The use case has no effect

Table 13.1 (continued)

UC-1	To vote	
	P_1	If the pair list includes some option identifier that does not exist in the voting, then the system describes the error to the actor. The use case has no effect
	P_1	If the pair list includes repeated options, the system describes the error to the actor. The use case has no effect
	P_1	If the voting session is not open, the system informs to the actor. The use case has no effect
	P_2	If there previously was a recorded vote of the participant in that voting, it is replaced by the new one
	P_3	If the pair list was empty, the system informs the actor that the vote of the participant <participant identifier>, in addition to being properly registered, was a blank ballot. Then, the use case continues
	P_3	If mark intensities did not adjust to the counting method, the system informs the actor that the vote of participant <participant identifier>, in addition to being properly registered, was a null ballot, explaining the reason in detail. Then, the use case continues
Comments	• Note that the options in a null ballot are also recorded • A blank ballot is a vote with no marks • The system does not permanently mark the vote as null, blank or normal (see Fig. 13.4), but every time you want to know, analyses them • Marking an option with 0 is different from not marking it, since the meaning of 0 may depend on the counting method • The list of pairs does not have to include all options in a voting. Not including an option in the list means that it is not marked	

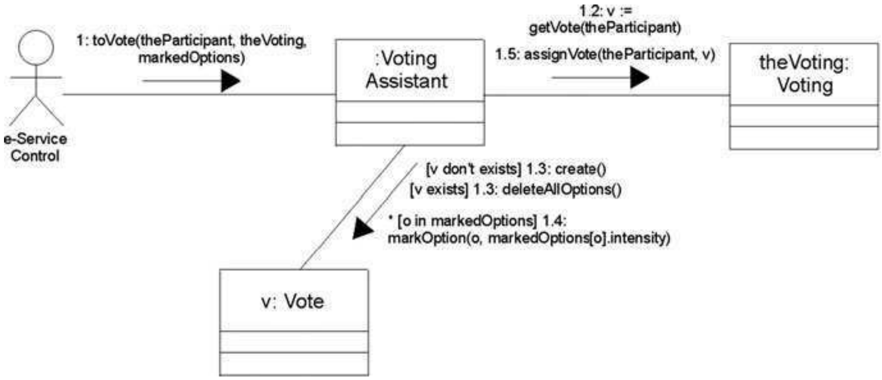

Fig. 13.6 Communication diagram of the use case 'To vote' for its normal scenario and that in which there is already a previous vote

In Fig. 13.6, we see the UML communication diagram of the normal scenario of the use case 'To vote'. It also shows what happens if there is already a previous vote of the actor in the same voting.

The class 'Voting Assistant' is necessary to create the votes. It is the controller in the MVC model (Gamma, 2003). Therefore, it belongs to the 'Design' stage and does not appear in the class diagram ('Analysis' stage) shown in Fig. 13.4.

13.7.1.2 Use Case 'To Delete My Vote'

The textual description of the main scenarios of the use case 'To delete my vote' appears in Table 13.2.

Figure 13.7 shows the UML communication diagram of the normal scenario of the use case 'To delete my vote'.

13.7.1.3 Use Case 'To See My Vote'

The textual description of the main scenarios of the use case 'To see my vote' appears in Table 13.3.

Figure 13.8 shows the UML communication diagram of the normal scenario of the use case 'To see my vote'.

13.7.2 Use Cases of the Package 'Voting Management'

We provide now the use cases of the package 'Voting management'. Recall that security restrictions, such as who can participate in a voting, are not included in our voting system but in the Security Manager previously described.

Table 13.2 Textual description of the use case ‘To delete my vote’

UC-2	To delete my vote	
Associated goals	To execute voting	
Short description	Through this use case, a participant can delete his previous vote in a voting	
Preconditions	• The voting must be open • The participant has previously voted in the voting session	
Normal scenario	*Step*	*Action*
	P_1	The actor initiates the use case, sending the following information to the system: • Participant identifier • Voting identifier
	P_2	The system deletes the previous vote of the participant <Participant identifier>
	P_3	The system informs the actor that the vote of participant <Participant identifier> has been successfully deleted
Postconditions	The participant has not voted in the voting	
Exceptions	*Step*	*Action*
	P_1	If the voting identifier does not exist, the system informs the actor. The use case has no effect
	P_1	If the voting is not in started state, the system informs the actor. The use case has no effect
	P_2	If there previously was not a recorded vote of the participant in that voting, the system informs the actor. The use case has no effect
Comments	Any hint that the participant has ever voted on that voting is eliminated in the Decision-Making Database. The activity is recorded in the logs	

- To create a voting session (UC-4).
- To delete an existing voting session (UC-5).
- To modify the state of a voting session (UC-6). It allows to change the state of a voting session (created, started or finished).
- To modify the properties and configuration of a voting session (UC-7). It allows the modification of the voting name and other minor properties.
- Use cases related with option management:

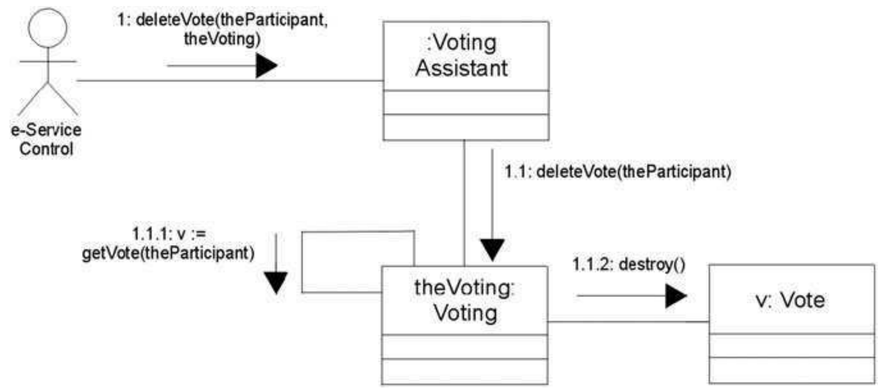

Fig. 13.7 Communication diagram of the normal scenario of the use case 'To delete my vote'

Table 13.3 Textual description of the use case 'To see my vote'

UC-3	To see my vote	
Associated goals	To execute voting sessions	
Short description	Through this use case, a participant can view his previous vote issued in a voting, or verify if there is a vote owned by him in that voting	
Preconditions	None	
Normal scenario	*Step*	*Action*
	P_1	The actor initiates the use case, sending the following information to the system: • Participant identifier • Voting identifier
	P_2	The system gets the vote of the participant <Participant identifier>
	P_3	The system checks whether the vote is null or blank
	P_4	The system informs the actor about the vote of the participant <Participant identifier>
Postconditions	None	
Exceptions	*Step*	*Action*
	P_1	If the voting identifier does not exist, the system informs the actor and the use case has no effect
	P_2	If the participant identifier does not exist, or if there is no previously recorded vote of the participant in that voting, the system informs the actor, and the use case has no effect
Comments	None	

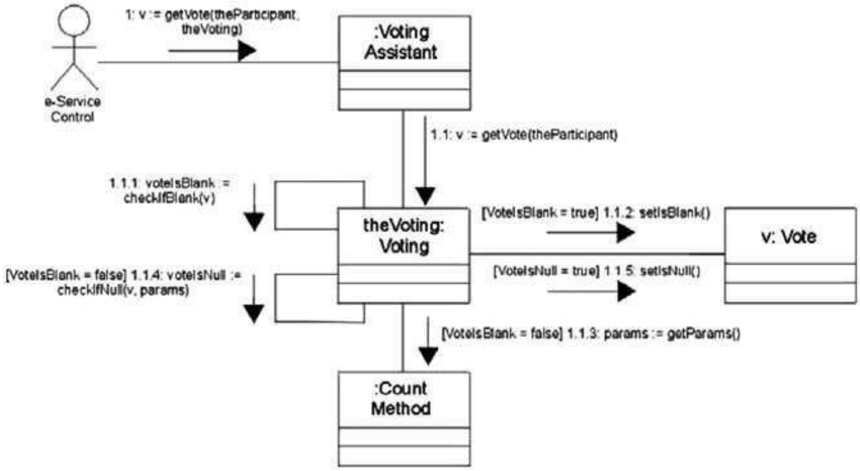

Fig. 13.8 Communication diagram of the normal scenario of the use case 'To see my vote'

- ○ To create option in a voting session (UC-8). It allows the insertion of a new option in a voting session.
- ○ To modify properties of an option in a voting session (UC-9). It allows the modification of the name and other minor properties of an option in a voting session.
- ○ To delete option in a voting session (UC-10). It allows the deletion of an option.

13.7.3 Use Cases in the Package 'Information Provision'

The use cases are as follows:

- To see the state of a voting session (UC-11). A use case related with UC-6.
- To see the properties and configuration of a voting session (UC-12). A use case related with UC-7.
- To see the result of a voting session (UC-13). It enables the calculation of current statistics of a voting session. It is not necessary that the voting is closed, as this restriction will be controlled by the Security Manager.
- To see the list of votes in a voting session (UC-14). It enables a summary of all individual votes issued in a voting (who voted and what each one votes, etc.) for verification purposes or otherwise – not to be confused with UC-3.
- To see the options in a voting session (UC-15). It enables one to see the list of options that a voting session currently includes, together with the properties of each one.

- To see/search voting sessions (UC-16). It enables one to see and search all voting sessions that have been or are in the system.
- To see logs (UC-17). It enables the exploration of the log for security verification purposes.

13.8 Conclusions

Dealing with remote electronic voting is clearly a major issue in the effective implementation of *e*-democracy. Therefore, it requires careful attention not only concerning security, which is possibly the most popular subject, but also in the specifications (requirements) and analysis/design of the software system that implements it.

In this chapter, we have established the basis for the specifications, analysis and design of such system. To do this, we first reviewed successes and failures in *e*-voting, ending with the case of Estonia in 2007, the first successful general election in which remote electronic voting was used, see **Madise and Maaten**. Note, however, that the Estonian system was not generic, nor was included within a global *e*-government system, nor had all the security considerations that we discussed. In fact, in Estonia, the remote electronic voting coexisted with the traditional one, which partly simplified the security considerations. We have assumed here that remote electronic voting was the only possible way for voting.

With that background in mind, we have built our remote electronic voting system. First, we have described briefly our *e*-government overall system, which includes our Voting Manager. Then, we have briefly mentioned goals, actors, interfaces and dependencies, as recommended by ANSI/IEEE 830-1998. Finally, we extended a little more about its safety, data structure and functional requirements. Regarding security, we think our remote electronic voting system is at least as reliable as traditional voting methods. Concerning data structures, this is only the systematic description of a subset of the Decision-Making Database. Finally, functional requirements are described by listing the use cases of the system, describing three of them more extensively as example. With all this in mind, it should be easy to build a system following our recommendations.

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Chapter 14
Explanation Systems

Jutta Geldermann

14.1 Introduction

Modern information and communication technology (ICT) is the basis for decision support systems to aid groups in undertaking decision making; see **French**. Recent developments in Internet technologies and ubiquitous computing facilitate citizen participation in an unprecedented way. Stakeholders may become involved in a decision process and articulate their views within the deliberations. Stakeholder participation is believed to increase the quality of policy analysis and acceptance of policy making. The challenge is the integration of the perspectives of all persons involved in a decision process, having different views and responsibilities. Decision makers (DMs) are those responsible for the decision. Stakeholders share, or perceive that they share, the impacts arising from a decision and therefore they claim that their perceptions should be taken into account. Experts provide economic, engineering, scientific, environmental and other professional advice. Analysts are concerned with the synthesis of the DMs' and stakeholders' value judgements and the experts' advice. Altogether, they bring a wealth of data, information and judgements, which need to be structured in the course of a decision process. Most importantly, decision analysis aims at separating values (mainly represented by stakeholder views) and science (mainly contributed by experts). Multi-criteria decision analysis (MCDA) has developed as a discipline of operations research for complex decision process support. According to Snowdon (2002), in complex decisions there are so many interacting causes and effects that predictions of system behaviour – often of a socio-political nature – are affected by a wide range of uncertainty. Therefore, on one hand, stakeholder involvement and citizen participation is important to bring together as much knowledge as possible. On the other hand, the result of a decision process has to be communicated to all involved parties in a transparent and comprehensible manner. Otherwise, the result would most likely not be accepted by the participants. While many approaches for MCDA have been developed in the

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last decades, they need to be adjusted to the needs of *e*-Participation. Explanation Systems, as developed in the context of expert systems and artificial intelligence, can help to explain MCDA output to users to build their understanding, as we shall illustrate here.

Before describing the various components of an explanation system, some basics of multi-attribute value theory (MAVT) as one field of research within MCDA are presented below. A case study from nuclear emergency illustrates the combination of MCDA, moderation techniques and explanation systems, which together help to support the synthesis of various stakeholder perspectives. Finally, the main results are summarized and further strands for research and applications are outlined.

14.2 Multi-attribute Value Theory (MAVT) for Group Decision Support

MCDA is a field of research which is concerned with the structured evaluation and support of decision problems with multiple criteria and uncertainty (Belton and Stewart, 2002; Clemen, 1996; see also **Efremov** and **Ríos Insua**). They are considered as explicitly subjective decision analytic techniques in which value judgements are obtained and modelled through multi-attribute value and utility functions (Keeney and Raiffa, 1976). The distinction between value and utility functions is that the former incorporate no notion of risk attitude and thus apply in conditions in which there is no or, more likely, negligible uncertainty. The latter explicitly acknowledge risk and are suited to decision making under uncertainty, but require more information from the decision makers. Thus, in the following, only multi-attribute value theory (MAVT) is described in more detail. MAVT provides methods to structure and analyse decision problems by means of attribute trees (also called value trees) and to elicit the relative importance of criteria in this setting. In an attribute tree, the overall goal or objective is divided hierarchically into lower level objectives (also called criteria) and measurable attributes (also called lowest level or leaf criteria). A decision alternative x is evaluated on each attribute, i, by means of a value function $v_i(x)$. Under the assumption of mutual preferential independence of attributes, the standard additive aggregation rule can be used (Keeney and Raiffa, 1976). Then, the overall value of an alternative x is evaluated as

$$v(x) = \sum_{i=1}^{n} w_i v_i(x),$$

where n is the number of attributes, w_i is the weight of attribute i and $v_i(x)$ is the rating of an alternative x with respect to attribute i. The sum of the weights is normalized to one and the component value functions $v_i\,(\cdot)$ have values between 0 and 1. The weights w_i indicate the relative importance of attribute i changing from its worst level to its best level, compared with the changes in the other attributes.

Weights can be elicited by different procedures. The simplest way is to give them directly by point allocation, but many weighting methods have been developed (von Winterfeldt and Edwards, 1986). For comparison and details of the use of different methods (see Pöyhönen et al., 2001; Belton and Stewart, 2002). There are also a number of techniques for the specification of the value functions. However, in many cases the assumption of linear value functions is justified if the set of outcomes of the alternatives are not very far apart.

For group decision support, aggregation methods are most commonly used while also game theory and negotiation models are available (see Bui, 1987; Cao and Burstein, 1999; Jelassi et al., 1990; Kersten and Szapiro, 1986; **Efremov** and **Ríos Insua**). To this end, the individual value functions are transformed into an overall value function, for instance according to the voting power of the members of the decision group. Since this would mean a kind of weighting of the group members, in practical applications of MAVT the decision group agrees upon one common set of weighting factors. Both ways lead to a common utility function as a compromise solution. Especially the weighting as the most subjective part within the decision process is subject to ongoing research both in prescriptive and descriptive decision theory. For instance, it is pointed out that the weight attributes are not independent of the range of the attribute scores (Pöyhönen et al., 2001). Although not all scientific questions have been sufficiently answered, decision support is needed for real-world decision problems, as the current tendencies in *e*-participation show.

Many software packages for MCDA have been developed in the last decades (see e.g. Behzadian et al., 2009; Belton and Stewart, 2002) and are used for group decision support. For instance, Web-HIPRE is a Java-based software for decision analytic problem structuring, multi-criteria evaluation and prioritization, which can also be used via Internet (Hämäläinen, 2003). Its application to a case study is illustrated further below in this chapter.

14.3 Explanation Modules

Originally, explanation systems were developed in the context of expert systems and artificial intelligence. Advice is given on grounds of a knowledge base and of certain logical rules. The actual explanation module elucidates the conclusion which was reached by the expert system. It has been shown that suitable explanation capabilities contribute to positive user attitudes towards the expert system's results and improve user performance (Gregor and Benbasat, 1999). They have proved to be useful for both experienced professionals and novices (Mao and Benbasat, 2000). Moreover, they influence user perceptions such as trust, confidence and satisfaction and increase levels of acceptance and learning (Dhaliwal and Benbasat, 1996).

Likewise, multi-criteria decision support can benefit from user-friendly explanations. While analysts are familiar with the output of a decision support system and the mechanisms of the underlying algorithms, the experts, the decision makers and the stakeholders are less likely to be so. Since most complex decision problems are tackled in an iterative manner, validation and documentation of the actual findings is of outmost relevance.

Explanation Modules have been developed to justify the results of an MAVT analysis (Klein, 1994; Papamichail and French, 2003). By generating an audit trail, the Explanation Module seeks to support the decision team by communicating the results of the multi-criteria decision support system in an understandable way. It adds transparency to the ranking process, by generating two natural language reports (Papamichail, 2000):

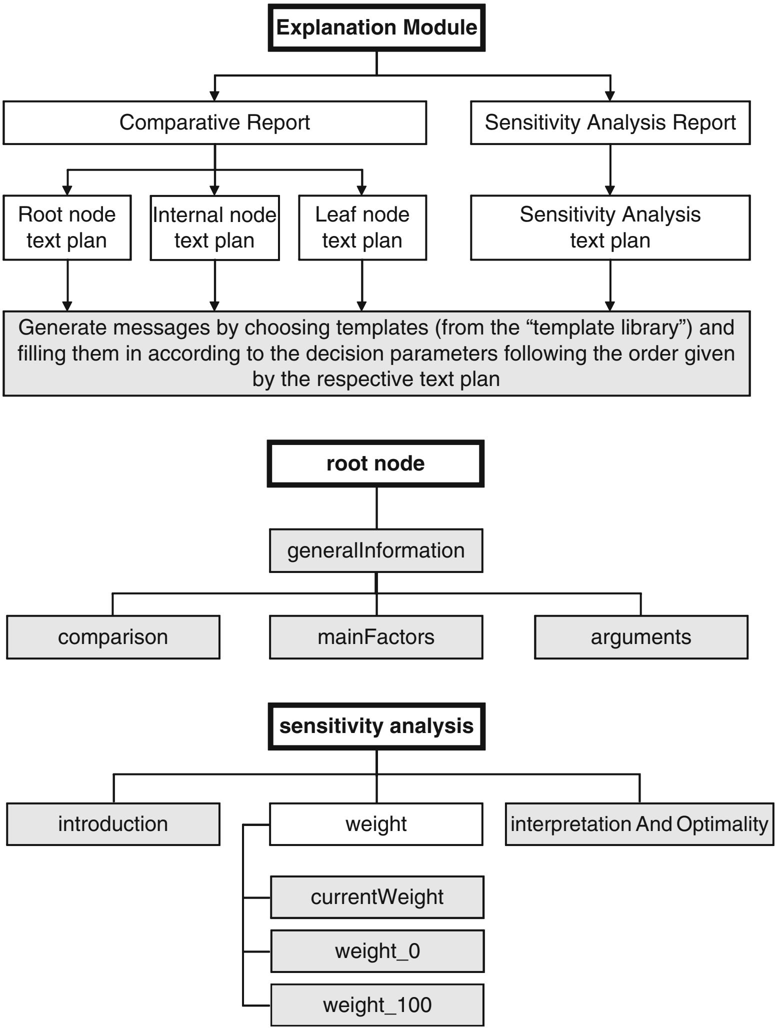

Fig. 14.1 Structure of the Explanation Module (*top*), with the text plans for the comparative report (*middle*) and for the sensitivity analysis report (*bottom*)

- A “Comparative Report” interprets the evaluation results and compares two alternatives. The report discusses how well one alternative rates over the other on each evaluation criterion, outlining arguments for and against each alternative, based on the actual criteria scores. Thus, it examines how much better an alternative is over another and highlights factors that differentiate between two alternatives.
- A “Sensitivity Analysis Report” explains sensitivity analysis graphs, illustrates the effect of changing the weight[1] of an attribute in the ranking of the alternatives and discusses the robustness of the most preferred alternative.

Figure 14.1 (top) illustrates the general structure of the Explanation Module. Its input comprises qualitative data in the form of an attribute tree as well as quantitative data in the form of a decision table. A decision table (also called performance table) contains the scores of the alternative strategies on each attribute, for example, see Table 14.1. It can also contain the decision parameters, such as the weights and the value functions. The Explanation Module then applies natural language techniques (Reiter and Dale, 2000) and statistical methods (Klein, 1994) to generate understandable reports in English. The user interacts with the interface of the Java-based MCDA tool Web-HIPRE (Hämäläinen, 2003) and submits a command which is then translated into a communicative goal such as “compare ‘*alternative i’* with ‘*alternative j’* relative to the ‘*criterion k*’” and “interpret the results of a sensitivity analysis on the weight of the selected attributes”. The Explanation Module processes these communicative goals and initiates the natural language generation process which involves three stages (*cf*. Fig. 14.1):

- *Content determination* which involves what type of report to generate (i.e. comparative report or sensitivity analysis report) and what type of explanations to convey to the users.
- *Discourse planning* which involves establishing the structure of the report, i.e. structuring messages in a coherent way by choosing an appropriate text plan (Fig. 14.1 illustrates text plans for a root node and the sensitivity analysis report).
- *Sentence generation* which involves selecting text-based templates and filling in qualitative and quantitative values to produce explanations in natural language form in order to convey messages.

The Explanation Module codifies the decision model in two forms: qualitative, e.g. the structure of the attribute tree, and quantitative, e.g. weights. Altogether, the Explanation Module produces five types of explanations: (1) model parameters, (2) statistical comparisons, (3) reasoning, (4) knowledge representation and (5) sensitivity analysis, which are presented in more detail in the following.

[1] A sensitivity analysis of the scores would have to be solved by parametric optimization and would require much more computing power.

Table 14.1 Decision table for the fictitious case study

Criteria \ Alternatives		A	B	C	D	E	F	G	H
		No action	Disposal of milk	Processing of milk	Storage of milk	Immediate removal of cows from contaminated feed	Removal of cows from contaminated feed after a while	Animals are given less contaminated feed	Adding of concentrates to the food which reduce the activity concentration (of milk and meat) and subsequent processing
		No action	disp	Proc	stor	rmov, $T=0$	rmov, $T>0$	rduc, $T=0$	addS + proc
Values directly imported from RODOS									
Avoided individual dose (adults – 1 year)	[mSv]	0	6.77E–1	1.44E–2	3.16E–5	1.20E–2	4.50E–3	1.69E–3	4.10E–2
Avoided individual dose (children – 1 year)	[mSv]	0	1.35	2.88E–2	6.32E–5	2.39E–1	9.00E–3	3.30E–3	8.10E–2
Avoided collective dose	[man Sv]	0	1.20E+4	1,756.62	71.0215	6,194.81	1.58E+3	1.14E+3	2.56E+3
Collective dose	[man Sv]	1.26 E+4	7.89E+2	1.09E+4	1.26E+4	6.48E+3	1.11E+4	1.15E+4	1.01E+4
Max. individual dose received by worker	[mSv]	0	0	0	0	1.25E–3	9.01E–4	1.07E–3	0
Collective dose received by worker	[man Sv]	0	0	0	0	2.42	6.14E–1	7.88E–1	0
Necessary number of workers needed to conduct a measure	[#]	0	0	0	0	658	532	547	0
Total amount of food above the limit	[kg]	1.12 E+8	1.12E+8	1.61E+7	1.12E+8	4.86E+7	8.3E+7	1.08E+8	1.46E+7
Amount of food above the limit after 1 year	[kg]	1.22 E+5	1.22E+5	0	1.60E+3	3.12E+3	3.12E+3	3.12E+3	0
Size of affected area	[km^2]	2,640	2,640	1,787	2,640	179	2,640	2,615	1,787

Table 14.1 (continued)

Values estimated by experts and stakeholders (range 0–100)								
Supplies (e.g. (agricultural) machinery) required to conduct a measure	0	10	10	20	40	40	30	80
Costs to conduct a measure	90	100	20	50	20	20	20	35
Acceptance of a decision by the public	0	100	5	15	80	80	30	5
Acceptance of a decision by the affected producers (e.g. agriculturists)	0	20	70	60	100	100	80	50
Acceptance of a decision by trade and industry	0	40	5	50	80	80	60	5

mSv: millisievert, with Sv = sievert as the SI derived unit of dose equivalent, as a measure for harmful health effects of ionizing radiation. manSv: a unit for collective dose in a population group (sum of doses of all exposed individuals)

14.3.1 Explanation of Model Parameters

Explanations of model parameters communicate the values of decision parameters such as the scores of the alternatives and the weights of the attributes, taking into account the structure of the attribute tree and, therefore, relationships between attributes (e.g. whether an attribute is linked to a root node or an internal node). The following example highlights the text parameters in _*italic*_:

> _*Criterion.x*_ with respect to the _*Subcriterion.y*_ accounts for _*value*_ of the determination of _*Criterion.x*_ and for _*value*_ of the determination of _*Goal*_.

For example, applying this to the example shown in Fig. 14.2, "total utility" is the goal, "rad. Effectiven." is the criterion on hierarchy level 1 and "*dose received by the workers*" the criterion on hierarchy level 2:

> Radiological effectiveness with respect to the "dose received by the workers" accounts for 10.0 percent of the determination of radiological effectiveness and for 1.15 percent of the determination of total utility.

This type of explanations can assist decision makers in reviewing and refining the parameters of the decision model. If they are not satisfied with these explanations, they could modify the values of the decision parameters (e.g. attribute weights or strategy scores).

14.3.2 Statistical Comparisons

Statistical explanations focus on determining the decision parameters that are relevant in ranking strategies. They are based on statistical interpretations (Carter, 2005) of the scores in the decision model. In our case, the decision parameters that influence the final ranking are attribute weights, strategy scores and absolute differences between strategy scores. For instance, in order to describe how good a strategy is relative to a chosen objective, the following text template is generated by the Explanation Module:

> _*Alternative id*_ provides _*semantic quantifier*_ _*Objective*_ in the context of all available strategies,

as in

> *Alternative C* provides ***very poor*** *operational costs* in the context of all available alternatives.

A semantic quantifier is a verbal expression (such as "substantially better", "slightly worse" or "significantly better") that describes the quality of a parameter and can be determined in the following way. Given an objective, the mean μ and the standard deviation σ of the scores of all available strategies relative to this objective can be calculated. Assuming that the score of a certain strategy is $s = 5$ on a scale from 0 to 100, the quality of the strategy can be described by mapping s (i.e. the score of the strategy) to a discrete set of semantic quantifiers: {"very good", "neither very good nor very poor", "very poor"} as follows (where λ is a user-defined constant):

$$\begin{aligned}
&\text{if } s > \mu + \lambda\sigma \rightarrow \text{“very good”;}\\
&\text{if } \mu - \lambda\sigma \leq s \leq \mu + \lambda\sigma \rightarrow \text{“neither very good nor very poor”;}\\
&\text{if } s > \mu - \lambda\sigma \rightarrow \text{“very poor”.}
\end{aligned}$$

Statistical explanations help decision makers to concentrate on those aspects that are significant in the decision process and, therefore, considerably reduce the time needed for parameter assessment. Of course, further semantic quantifiers for a finer graduation can be formulated and statistically defined.

14.3.3 Sensitivity Analysis Explanations

While a graphical representation of the sensitivity analysis is preferred by many persons, an additional textual explanation of such (in) sensitivity graphs is especially welcomed by novices in multi-criteria decision support. These explanations interpret sensitivity analysis graphs, which are state of the art in result representation in MCDA systems.

The sensitivity analysis explanations discuss the optimality of strategies according to their sensitivity and report those values of decision parameters which lead to different evaluation results. Figure 14.6 shows an example of a sensitivity analysis report for the case study.

14.3.4 Reasoning Explanations

Reasoning explanations describe how conclusions are derived from the formal mathematical model employed by the system and can discriminate factors that support a choice from factors that do not. For example:

> While the *criterion* "*resources*" is the main reason to prefer *Alternative B*, this is outweighed by considerations of the *criterion* "*impact*", along with other less important factors, that provide reasons for preferring *Alternative C*.

The explanation system generates the reasoning report by calculating value differences of the two strategies (B and C) relative to all the objectives. There is a reason to prefer an alternative if there is, at least, one positive value difference, with all other scores being equal. If there are more than one positive value differences, the objective with the highest positive difference (depending on score and weight of the considered criterion) is the main reason to prefer that alternative. The main reasons to prefer an alternative are identified by interpreting the negative value differences in a similar way.

Explanations of reasoning provide an overall assessment of the preferences and values stated in the decision model and offer valuable insight into the problem at hand. They illustrate the most significant factors in the ranking of alternatives and highlight arguments for or against a choice.

14.3.5 Knowledge Representation Explanations

Knowledge representation explanations convey qualitative information, illustrate the structure of the attribute tree and describe the attributes and alternatives taken into account. Text is generated taking into account the structure of the attribute tree, as well as information about attributes and strategies, for example (see also Fig. 14.4 for a comparative report generated for the case study):

- This judgement takes into account the effects of the criteria "effectiveness", "resources", "impact" and "acceptance".
- Comparison of Alternative B and Alternative C with respect to total utility and the criterion "effectiveness".
- Such explanations highlight how the attribute tree is structured and outline the criteria taken into account in the ranking of alternatives. They help decision makers identify attributes that appear to be less important but, nevertheless, are being considered in the overall evaluation.

These five types of text reports generated by the explanation system have been implemented as an add-on to the MCDA-tool Web-HIPRE (Bertsch, 2008) and back up the commonly used graphics. Decision analysts who are well familiar with the logic and procedures of decision support, such textual explanations may seem redundant, and "picture is worth a thousand words". But especially *e*-participation appeals to novices in decision analysis who are unable to interpret the graphics delivered by MCDA software tools. At least for a first understanding, such textual explanations are of help, as the tests in a series of moderated workshops on emergency management demonstrated. In the following, a case study is presented in order to illustrate the use of the explanation system.

14.4 Case Study: Decision Support in Emergency Management

Emergency management and recovery is a typical example of complex decisions, where the viewpoints of many stakeholders should be taken into consideration. In general, emergency management deals with disasters, which may drastically and immediately affect people's lives and livelihoods. Disasters may be 'natural' such as floods, fires, storms, earthquakes, droughts and volcanic eruptions or 'man-made' such as radioactive and hazardous materials accidents (French and Geldermann, 2005). Many conflicting objectives must be resolved and priorities must be set while the various perspectives of many stakeholder groups must be brought into some form of consensus.

Nuclear emergency management is different to emergency preparedness and management which often involve contingency plans or checklists that have been prepared in advance and are more or less regularly utilized in emergency exercises. In the early phase emergency management involves urgent decisions on short-term measures such as evacuation, sheltering or distribution of stable iodine. In the longer term, more complex decisions on remediation strategies and agricultural countermeasures are required, which can be supported by MCDA. One system that offers comprehensive support in managing nuclear or radiological incidents is the real-time online decision support system (RODOS), which will be briefly introduced. Thereafter, the application of MAVT in combination with an explanation system will be described in the course of moderated decision making workshops.

14.4.1 RODOS

RODOS is designed to provide consistent and comprehensive information in the event of a nuclear or radiological accident in Europe (see www.rodos.fzk.de). After the Chernobyl nuclear accident in 1986, the development of RODOS became a major item in the area of radiation protection of the European Commission's Framework Programs (Ehrhardt et al., 1993).

The support provided by RODOS ranges from largely descriptive reports, such as maps of the predicted, possible and, later, actual contamination patterns and dose distributions, to a detailed evaluation of the benefits and disadvantages of various countermeasure strategies and their ranking according to the societal preferences, as perceived by the decision makers (French et al., 2000). Models and databases within RODOS contain extensive information about site and plant characteristics of the different nuclear power stations in Europe and the geographical, climatic and environmental characteristics. Its operational application requires on-line coupling to radiological and meteorological real-time measurements and meteorological forecasts from national weather services. RODOS is characterized by its conceptual architecture which consists of three subsystems:

- The Analyzing Subsystem (ASY) modules process incoming data and forecast the location and quantity of contamination, including temporal variation.
- The Countermeasure Subsystem (CSY) modules simulate potential countermeasures, check them for feasibility, and calculate their expected benefit in terms of several attributes.
- The Evaluation Subsystem (ESY) supports the ranking of countermeasure strategies according to their potential benefits or drawbacks, preference weights and value functions provided by the decision makers.

In order to focus on the needs of the decision making process, the MCDA tool Web-HIPRE (Hämäläinen, 2003) has been integrated into the Evaluation Subsystem of RODOS transparently and coherently supporting the evaluation of possible countermeasure and remediation strategies (Geldermann et al., 2005; Raskob et al., 2005). A specific "Explanation Module" (Papamichail, 2000; Papamichail and French, 2003) generates natural language reports that explain the results of the decision analysis and, moreover, form an audit trail and has been implemented into Web-HIPRE (Geldermann et al., 2009).

14.4.2 Moderated Decision-Making Workshops

The new evaluation tool in RODOS has been tested in a series of workshops across Europe to demonstrate its capabilities and gather feedback on whether such a tool could be applied in the decision making process in nuclear emergencies. A series of moderated workshops was organized in some European countries within the EU-Project EVATECH (Information Requirements and Countermeasure *Eva*luation *Tech*niques in Nuclear Emergency Management). In Germany, one of the workshops focused on agricultural countermeasure and remediation strategies. It was organized for 18 participants, including officials and politicians of regional, state and federal authorities, who represented the different stakeholder and expert groups in emergency management (Geldermann et al., 2009).

A hypothetical radiological accident scenario formed the basis of the case study. The fictitious contamination in the scenario was assumed to be caused by a serious accident at a nuclear power plant which triggered the immediate shutdown of the reactor. In advance of the workshop, background material, an explanation of the introductory case study, and preparatory information for using the MCDA tool Web-HIPRE were sent to the participants. The RODOS system was used to calculate the necessary data for the hypothetical accident scenario before and during the workshop. The main objectives of the workshops were:

- Exploration of information and data requirements for the decision makers.
- Identification of the factors driving decision making in the context of agricultural nuclear emergency management.

- Development of methods for stakeholder involvement in exercises and emergency planning.
- Application of the evaluation software Web-HIPRE and the Explanation Module.

After an analysis and forecast of the radiological situation, eight alternatives as potential countermeasure and remediation strategies are examined within the scenario. The case study was analysed and structured in a moderated discussion (Geldermann and Rentz, 2004; Seifert, 2002). At first, the workshop participants determined the relevant decision criteria from the list of criteria available in RODOS. Additional important criteria which are not provided by RODOS were identified by the workshop's participants via card inquiry.

Table 14.1 summarizes the decision table, listing the alternatives and criteria and providing the data and judgements used. Whereas the data compiled in the upper part directly result from the RODOS system, the values in the bottom are estimated judgementally by the attending stakeholders and experts. For the latter, a scale ranging from 0 to 100 is assumed, where 100 corresponds to the highest value and 0 to the lowest. The values have been defined after sound discussions in consensus. It should be noted, that though some attributes, such as costs to conduct a measure, are measurable on a cardinal scale (as in Euros), but the actual data collection (as for wages of workers, exact number of required workers, costs of equipment) would be paramount and even not exact. Thus, just a rough estimation if costs are higher or lower has been performed.

The collection, structuring and variety of information presented during discussion provided deeper insight into the issues under scrutiny and led to some form of shared understanding amongst all participants of the workshop. As an interim result, the attribute tree (*cf.* Fig. 14.2) shows the overall aspired goal "total utility"[2] (of an alternative or strategy) as the leftmost criterion being split up into the criteria "radiological effectiveness", "resources", "impact" and "acceptance", each of which is split up again.

As a first step of the preference elicitation, the weighting of the criteria of the attribute tree (*cf.* Fig. 14.2) was carried out in a group discussion using direct and SWING elicitation methods for the weighting factors (von Winterfeldt and Edwards, 1986). Subsequently, the value functions were defined for each individual attribute using both linear and exponential functions, as considered appropriate by the participants. Finally, the composite priorities (*cf.* Fig. 14.3) were calculated and illustrated by Web-HIPRE. Figure 14.3 shows that Alternative E ("rmov, T = 0") is the most preferred alternative followed by Alternative B ("disp"). It can be read of the screenshot Fig. 14.3 shows that the criterion "acceptance" provides a large contribution to the good overall performance of both of these alternatives, but the criterion "impact" is the most important objectives in differentiating between them. Since the weights

[2]Since MAVT (multi-attribute value theory) has been applied, "overall value" might be more appropriate. However, during the workshops throughout Europe, the English translation "utility" has been used, which corresponds better to the colloquial understanding.

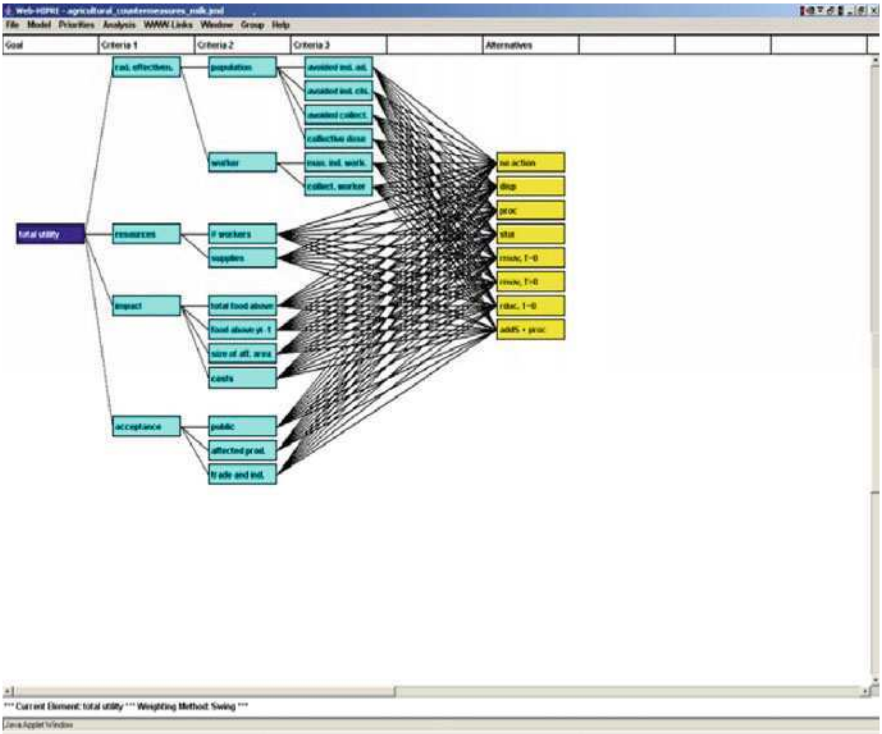

Fig. 14.2 Attribute tree for the exemplar case study

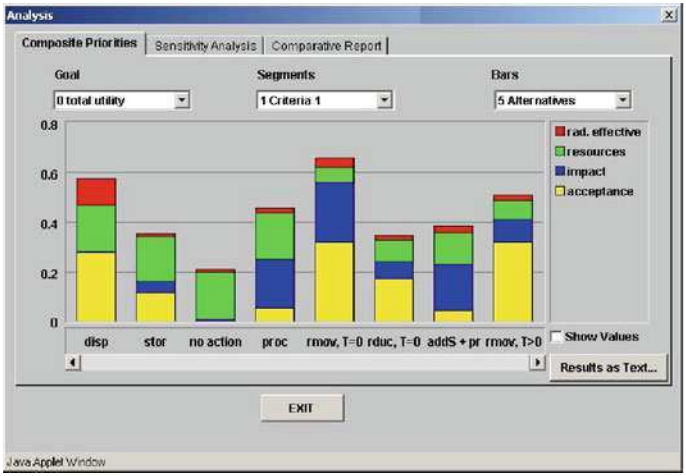

Fig. 14.3 Results of decision analysis illustrated by Web-HIPRE

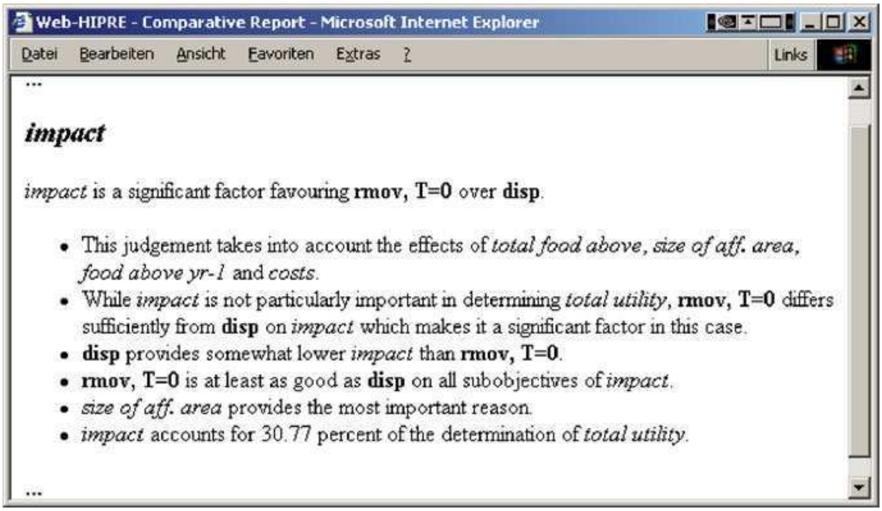

Fig. 14.4 Extract of a comparative report

assigned to "radiological effectiveness" and "resources" are comparatively small, the differences in the overall scores would provide reasons to favour the Alternative B ("disp") over Alternative E ("rmov, T = 0"), but this does not have a big effect on the results of the analysis.

The explanation module was used to generate comparative reports as well as sensitivity analysis reports to provide the results of the decision analysis in natural

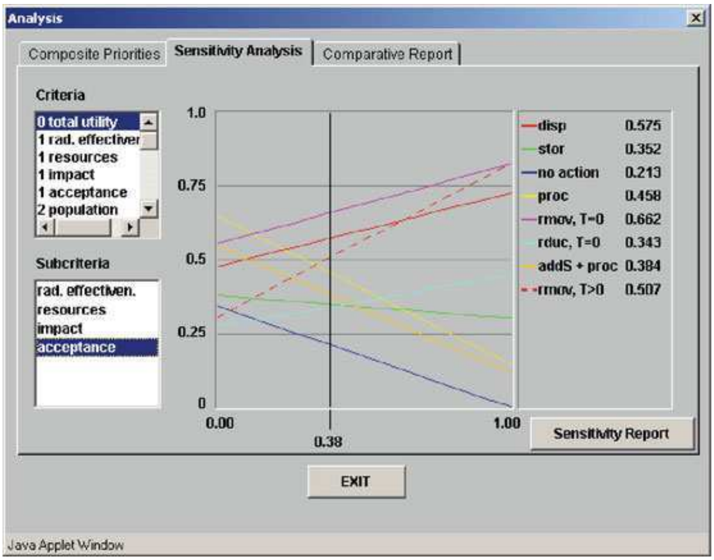

Fig. 14.5 Sensitivity analysis in Web-HIPRE

language format. Figure 14.4 shows the comparison with respect to ‘impact’ (an internal node of the attribute tree). In particular, a comparative report for Alternative B (“disp.”) and Alternative E (“rmov, T = 0”) provided deeper insight into the factors differentiating between the two alternatives.

In addition, a sensitivity analysis on ‘acceptance’ examined the robustness of the choice of an alternative relative to changes of the weight assigned to ‘acceptance’. The sensitivity analysis graph (*cf*. Fig. 14.5) shows the range of weights for ‘acceptance’ for which an alternative is the most preferred. Under the assumptions made above, the weight for ‘acceptance’ can be changed by approximately 26% without changing the optimality of Alternative E (‘rmov, $T = 0'$). For a further reduction of the weight, Alternative C (‘proc’) turns out to be the best choice. Figure 14.6 displays the sensitivity report delivered by the explanation system.

Sensitivity Analysis Report

Sensitivity Analysis for *total utility* on the weight of *acceptance*

This analysis examines how robust the choice of an alternative is to changes of the weight of *acceptance*.

The lines in the graph of the sensitivity analysis, each associated with one strategy, show the weighted scores of the (associated) strategies when the weight of *acceptance* is varied from 0% to 100%. The vertical line at 38.46 represents the status quo. The overall scores of the alternatives are:

Alternative	Overall Score
disp	0.575
stor	0.352
no action	0.213
proc	0.458
rmov, T=0	0.662
rduc, T=0	0.343
addS + proc	0.384
rmov, T>0	0.508

The ranges of the weights of *acceptance* for which an alternative is the most preferred are:

Weight range	Alternative
0.00 - 12.18	proc
12.18 - 100.00	rmov, T=0

The percentage on *acceptance* can be changed by as much as 26.28% without changing the optimality of **rmov, T=0**.

Fig. 14.6 Sensitivity analysis report on the criterion ‘acceptance’

At the end of the workshop the participants were asked to complete a questionnaire with statements about the suitability of decision making workshops for training and exercises for emergency situations. The general tendency of the responses was that the workshop was considered to be very useful for training purposes and that decision analysis helps to ensure the transparency of decisions and understand the opinions and views of other participants. In particular, many stakeholders emphasized that they perceived the explanation system as a valuable benefit for decision making because of the consequential deeper insight into the situation (Geldermann et al., 2009).

It can be concluded that the explanation module, which generates reports to explain the results of the decision analysis, contributes to the direct involvement of the decision makers by enhancing their understanding of the outcome of the evaluation process and subsequently increases the overall acceptance of the entire system. Furthermore, the generated reports form an audit trail and thus improve the traceability of decisions.

14.5 Conclusion and Outlook

Complex decisions require input from various disciplines and fields of expertise. Model building helps to bring together existing knowledge and to foster interdisciplinary teamwork. Moreover, models can be used to simulate different parameter variations and thus to generate results in different scenarios. However, due to the many issues that need be considered, the human capabilities of "common sense" are quickly overstretched, and multi-criteria decision support is needed. Especially Multi-attribute value theory (MAVT) is a suitable approach which offers methods to structure analyse decision problems by means of attribute trees and to elicit the relative importance of criteria in this setting. While decision analysts are familiar with the methodologies, other experts, stakeholders and the actual decision makers may not understand the results intuitively. Explanation systems deliver suitable reports in natural language. A case study from emergency response and management illustrates the benefits of Multi-Criteria Decision Aiding (MCDA) in combination with an explanation system, which puts in plain words the MCDA output to users to build their understanding.

With the advent of Internet and almost ubiquitous computing and communication technologies, citizen participation exist is much easier than it ever was. It allows new kinds of democratic processes. The challenge now is the explanation of the decision methodology to participants, regardless of their educational, professional or personal background. Only in this way a greater element of involvement and integration of the perspectives of all concerned stakeholders can be reached. There are, however, a number of open questions. The first one concerns the language used in explanation systems. While the implementation presented here uses English, translations into different languages are possible, taking the particular grammatical requirements into account. Since the text composed by the explanation system may sound artificial, a rephrasing of some sentences for written reports of the decision process may become necessary. Nevertheless, the formulations provided by the explanation system can give the coarse direction of the flow of reasoning. In general, the findings of risk communication should be taken into consideration for the design of text plans (Bier, 2001; Krimsky, 2007).

The application of an explanation system as an add-on to Web-HIPRE has been described for (nuclear) emergency and remediation management, which are typical multi-criteria problems involving economic, ecological and engineering questions as well as global political and socio-psychological issues. Because of the possible immense consequences of nuclear emergencies, much effort has been spent on the development of tools such as RODOS. The general approach, however, can easily be transferred to other applications, such as the dispersion of chemical or biological airborne substances emitted in industrial accidents (Jensen and Pehrsson, 2009). An increased awareness of the possibility of technical failure of industrial systems and an improved preparedness to cope with emergencies, e.g. caused by natural hazards, are desirable. Given the complexity of modern supply chains, a failure of parts of the value chain can cause the collapse of the whole system. Thus, the related decisions on emergency management and remediation strategies quickly become very complex and require appropriate decision support, taking stakeholders' perceptions into consideration.

The case study described a moderated workshop, in which MCDA was supported by moderation techniques. The moderation method (Seifert, 2002) is often used in quality circles or CIP (Continuous Improvement Process) work, as stimulated by ISO 9000ff norms on quality management or the approaches of Lean Production (Ono, 1988; Womack et al., 1990), as well as in conducting workshops, discussions and taskforce meetings, since company-internal decisions also become more democratic. Vice versa, moderation techniques could benefit from MCDA, which allow weighting the collected arguments during a moderation circle.

To conclude, it has to be stated that little research can be found on the borderline between decision support and psychology (Eigner-Thiel and Geldermann, 2009). Though this paper describes various types of explanation modules, their understanding – with or without further graphical representations – by different stakeholders is not yet investigated. Especially in *e*-democracy, many persons with very different backgrounds, expectations and perceptions are in involved in complex decision processes. Several authors (Ainsworth, 1999; Cox and Brna, 1995; Petre and Green, 1993) emphasize that the handling of graphical representations in general is not self-evident or even natural, but has to be learned, as any language. As long as understanding is not unambiguous (see also Kahneman and Tversky, 1974), decisions are prone to manipulations. Decision theory should do its best to explore decision situations and add transparency to the dynamics in real-world discussions.

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Part IV
Case Studies

Chapter 15
Transparent Public Decision Making: Discussion and Case Study in Sweden

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15.1 Introduction

It is sometimes argued that an essential shift from governing to governance is taking place, alternatively expressed as a shift from representative to deliberative democracy, from hierarchies to networks, or from direct control by the state to strategies designed to engage civil society in collaborative governance. Within this realm, the development has moved towards testing new means for democratic decision making, like *e*-panels, electronic discussion forums, and polls, especially at local government level. Although such new developments seem promising, they are not problem-free, and the outcomes of these processes are seldom used in the subsequent formal political procedures.

Within the field of *e*-government, the problem of obtaining more democratic decision making has been handled by stressing the importance and encouragement of broad participation facilitated by the use of ICT (Grönlund, 2003). The focus has until now mainly been on encouraging, as well as, occasionally, modelling, moderating, and reviewing discussions. Decision Support Systems (DSSs) have been successful in organizational contexts, and experiences have shown that DSSs could serve as a valuable tool for improving the effectiveness of decision processes, as well as, for the communication of decision activities with the general public (cf. Ekenberg et al., 2009). However, there is a need to investigate further the role and usability of the DSSs in democratic systems.

Although the concepts of participation and transparency have been discussed extensively within the area of public administration, so far there is no general agreement on how to improve the organization of participatory decision-making processes. There is a need to integrate the different aspects of participation and the technologies supporting them, as well as a need for tools designed to support more formal problem modelling and structuring of the decision-making process (cf. Rowe and Frewer, 2000). Decision support methods and prescriptive decision

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process models offer promising potential when it comes to structuring and supporting transparency of decision processes in order to facilitate the integration of the public into decision-making procedures in a reasonable and manageable way.

This chapter describes a structured process involving decision support methods applied in a case study carried out in the Swedish city of Örebro. Decision support methods for more deliberated decision making that, at the same time, is transparent are discussed as well as employed in a real-life decision. The method employed (ADL, the Analytical Decision Layer model) is based on earlier results concerning an infrastructure decision in Nacka municipality, east of Stockholm (Danielson et al., 2005, 2008). This earlier study proved the viability of the concept, but was originally not designed for enabling a generalization into a generic model for societal planning. The local government in Örebro consists of a city council containing several boards for different governing areas. In the following sections, the decision problem faced by the urban planning board of the city council is first presented. Thereafter, a background to DSS use in *e*-democracy is provided and the approach to the decision support tool (ADL) used in our case is discussed.

15.2 Decision Support in *e*-Democracy and Public Settings

In public settings, the role of a particular decision support system can differ depending on the design and execution of the decision process. As, for instance, Grönlund (2001) and Wilhelm (2000) discuss, evaluations of *e*-participation trials are few and relatively inconclusive. Findings include limitations in current procedures, such as web information often being static and one-sided, and goal-oriented discussions being difficult to pursue (Wilhelm, 2000). Moreover, there are important problems that are yet to be addressed within the *e*-government debate, such as formal problem modelling and modelling consequences of applying particular preferences in decision-making and decision- preparation activities. The ADL approach bridges two fields, *e*-participation and decision support, by addressing both the problem of communication, internally within the governmental body and externally to stakeholders, and that of modelling and analysis of decision alternatives.

In general, democratic decision making can be described as a five-stage cyclic policy making model (cf. OECD, 2003). These are (1) Agenda setting, (2) Analysis, (3) Creating the policy, (4) Implementing the policy, and (5) Monitoring the policy, where the initial step of each cycle is based on the outcome of preceding rounds. Public participation plays different parts in different democratic models, and consequently, the role of a public decision support system (PDSS) differs. In the *strong* democracy model, the public should participate in all stages and is often engaged in some way at each stage by advocates for *e*-democracy. In the *thin* model, the public is normally only consulted at two of the latter stages of the cycle, the policy creation and monitoring stages. Moreover, in the thin model, a PDSS is primarily a tool for the administrators, since it is usually employed at the analysis stage (preceding the policy creation stage). Nonetheless, the PDSS could also be employed as a pedagogical tool promoting process transparency. As such, it could be used to explain the reasons behind a certain decision, e.g., by providing the model and data used to arrive at the chosen solution. In contrast, the role of a PDSS in the strong model would rather be as an interactive tool to facilitate public discussion throughout most of the stages in the policy making model. The general public would be invited to modify weightings given to certain criteria and study the effects of different preferences. However, simply enabling more participation will not yield enhanced democracy; an adequate mechanism for participation exercises is a necessity regardless of democracy model (Wilson, 2000).

Except for the requirement of being clear and interactive in the above sense, the problems with formal modelling per se, and in particular with modelling the consequences of applying certain preferences, have so far received little interest within the *e*-democracy debate. However, the latter has turned out to be of great importance during the projects we have undertaken. Generally, during policy making processes several instruments have been used in order to enable interaction between actors such as decision-makers and stakeholders. Such instruments have often been discussed separately in the field of *e*-participation, both regarding interactions with the general public, between politicians, as well as between politicians and administrators. Since the contexts for such interactions differ, both methods and technologies to support them are expected to vary.

In order for a process to be regarded as democratic, the process must be sensitive to the interests of various stakeholders and, consequently, also (i) allow for modelling of outcomes based on different preferences, and (ii) allow for a negotiating process where different views can be interactively adjusted when considering calculated outcomes. Democracy, in contrast to most decision analytical models, is a negotiation between world views where there can be several 'best' solutions, each pertaining to a specific set of preferences. The democratic decision-making process must be attentive to process models derived from both approaches. On one hand, the stakeholders' different views must be acknowledged as input; on the other hand available facts must be used to increase stakeholders' insights into the outcomes of applying different preferences. As a consequence, the decision process should (1) be iterative and allow for preference alterations, and (2) include conflict resolution measures that allow stakeholders to alter their views without feeling 'defeated'.

More explicitly, the design of a clear, transparent, and interactive decision process encouraging active participation should include: a process model, an elicitation part containing the opinions and attitudes of the stakeholders, a decision process part, and an interaction part containing the means of communication directed towards the stakeholders. Building on previous cases (Danielson et al., 2005, 2008), a three-layer model has been developed. These process layers interact in several ways. The *stakeholder layer* (1) includes the interaction with the political process and the citizens. This is where the goals are set and later measured. The *middle investigation layer* (2) consists of the administrative process of the local government during which civil servants conduct the necessary investigations and assessments in order to carry the process further. This is also the layer with the responsibility of processing the information from the stakeholder layer (1); the views of the political governing council, the citizens, and other possible stakeholders, such as industry and adjacent communities and NGOs. Most of the structuring will take place in this layer, in addition to the processing of the obtained information into decision data. The *analysis layer* (3) consists of a decision support process having a decision analytic method and toolbox at its core. The information is gathered from previous investigations and workshops and formulated into statements in the investigation layer and used as input in the analysis layer. Thereafter, an iterative process starts, where the process participants gain insights and views are negotiated step by step.

In order to be better able to measure different effects of *e*-democracy efforts on the democratic process, the case presented in this chapter was divided into a two-stage process, where the first one concerns the *internal* democracy, i.e. the formulation and refinement of the decision problem and the interaction between politicians and civil servants. The second stage deals with *external* democracy, i.e. the communication with the public, where communication channels directed towards the citizens will be formed. Another rationale behind this two-stage process was the discovery through the use of problem structuring methods from the area of decision analysis of the proxy issue in the initial workshops, see below. Before an internal common understanding of the situation had been established, the politicians and civil servants were reluctant to include the general public. Thus, in this first stage, for the activities related to the stakeholder layer (1), the stakeholders studied were the politicians, whereas citizens' views are to be included in the process through a website in the second stage.

15.3 Analysis Toolbox

The decision problems faced are multi-criteria, multi-stakeholder problems involving decision-making groups with different views; see the section *Case Background*. There are then several possible candidates for analysis methodologies. Aggregations of utility functions are investigated in e.g., Fishburn (1970), Keeney (1992) and Keeney and Raiffa (1976). Implementations have been based on e.g. Edwards (1977), Saaty (1977) and Saaty (1980), the latter severely criticized by Watson and Freeling (1982, 1983). Other types of models, e.g., using geometric mean value methods were suggested in Barzilai et al. (1987), Krovak (1987) and Lootsma (1993). However, a problem with the approaches above is that there is a lot of uncertainty involved in the decision processes, and the requirement to provide precise decision information is unrealistic in public decision support situations.

In these processes, there is uncertain information involved, which makes it suitable to base the evaluations on a structured decision analytic method (Danielson, 2004; Danielson and Ekenberg, 2007). There are some later approaches that are interesting candidates for the analysis layer, such as the generic multi-attribute analysis (GMAA) system (Jiménez et al., 2006), dealing with uncertainty by allowing value intervals to represent incomplete information, about the alternative consequences, as well as, the decision-maker's preferences. Salo and Hämäläinen have also developed a set of tools, e.g. Salo and Hämäläinen (1995) that have been discussed, e.g. in Danielson et al. (2008). The case study needed to avoid acceptance difficulties, taking into consideration that all decision steps must be accepted and understood by the local government itself as well as the civil servants. For this purpose, a decision method was used in the analysis layer that conforms to classical decision theory but featured the possibility to express values and statements in the form of intervals and comparisons. This method has been employed and validated in a number of decision projects in the public sector, such as decision making concerning the deposition of spent nuclear fuel in Sweden, large purchasing decisions at the Swedish Railway Administration and investment analyses (Danielson et al., 2003a), as well as the design of a public-private flood insurance system for Hungary (Ekenberg et al., 2003). The method has been packaged into a decision tool (Danielson et al., 2003b), which facilitates the acceptance of the decision modelling approach in the case.

15.4 Case Background

The city of Örebro is situated in the central part of Sweden, 200 km west of Stockholm, and has a growing number of inhabitants, approximately 130,000 at present, which makes it the seventh largest city in Sweden. Örebro is a multifaceted business region and its geographical position makes it a natural logistic transportation centre in Scandinavia. The river Svartån runs through the municipality and the city itself, and there is a wide range of water related activities offered in connection with the river, which is 80 km long with a wide through-flow of water in an area stretching between several municipalities (Degerfors, Laxå, Lekeberg, and Örebro). Svartån starts from the lake Ölen and passes through several lakes, agricultural land, forests, and small communities along its path, before discharging into the lake Hjälmaren, the fourth largest lake in Sweden. The river's natural flow has for centuries been manipulated in order to obtain more agricultural land.

There is a strong public opinion in Örebro in favour of an increase in the number of bathing spots, and the natural occurrence of Svartån running through the city makes it a desirable target. It is a large asset which could be used for this very purpose if only problems with high bacteria count could be solved. High bacteria counts have hitherto prevented the opening of more bathing spots along the river. The organisms causing diseases are difficult to analyse in water samples, and therefore indicative bacteria for such testing have been selected. Their existence shows that there can be pathogenic micro organisms present, and from 2008 these indicative bacteria are E. coli and intestinal enterocytes. The different spots for public bathing along Svartån (e.g., Hästhagen and Våståparken) have been deemed unsuitable, according to EU regulations, since water samples indicate possible health risks for humans bathing in the water. For example, the popular bathing spot Hästhagen (upstream of the city), which encompasses a beach and public facilities, has been closed since 2005 for this reason.

Thus, the problem originally faced by the decision makers in the urban planning board was how to open more bathing spots in the area. During the initial workshops, see below, it was, by means of decision analytic techniques, discovered that the bathing problem was merely a symbolic proxy issue. The larger and much more complicated issue was that of long-term fresh water supply in the entire region. It was not purposeful to further process the original problem, and the escalated problems could not immediately be discussed in public before a more complete problem description was available. Recent activities to partially solve the problem and make it healthy to swim in Hästhagen had been the exploration of using a UV cleansing technique on a small part of the water, contained inside screens (encompassing the water surrounding the beach). These attempts belong, however, to the original proxy formulation of the problem, and they were found to be short term, expensive, and do not solve the bigger problem of poor water quality of the river in general.

Regarding the extended decision problem, the city of Örebro has since long faced problems with poor water quality in Svartån. For several years, there have been unacceptably high amounts of intestinal bacteria in the water, originating from human and different types of animal faeces. There are many theories on the main sources responsible for the high bacteria count, but the significance of the identified sources has not been possible to determine, neither quantitatively nor in relation to another. The knowledge of the bacteria's life span in the water is limited, and a central question is whether the specific characteristics of Svartån makes their life span longer or whether there is some specific cause that leads to the extended life span. So far, no such cause has been found, but one proposal is that the high opacity of the water or the water humus in the river diminishes its natural purification process. Moreover, the measures taken so far have not shown any apparent improvements, and there is a need for more investigations in order to make more precise judgements regarding the significance of the different sources of contamination, e.g., livestock manure entering the water, individual households with malfunctioning closet sewers, insufficient drainage systems for peak flows, sewer overflow, and urban water. There is a high bacteria count already before the river passes the city of Örebro, which implies that sources upstream of the city must be handled before any measures taken within the city itself can be expected to have a decisive effect.

Thus, the problem situation surrounding Svartån is complex. There are several stakeholders who could be affected differently, and there are different views on the need for and effect of different measures. The problems do not merely relate to bathing in Svartån, but also to the environmental condition of the river and involves other municipalities than Örebro as well. Consequently, this makes the matter even more complex and not merely a local, but also a regional issue (as other municipalities may have to take measures as well in order to solve the problems in the Örebro region).

The traditional model for municipal decision making is that the elected politicians, generally with some help of civil servants and experts, make most decisions in a closed group. Furthermore, there is often simply one proposal (prepared by the civil servants) which the governing politicians (the decision makers) either agree with or not. However, in line with the city council's objective of promoting a stronger deliberative democracy involving more people in decision-making activities, the members of the urban planning board agreed to use decision support methods as an aid in a structured transparent decision process. The actual decision makers are the governing politicians, but all political parties, even those in opposition, have been invited to participate in the work process as the problems with the Svartån has existed during several election periods. Due to this, the decision makers expressed a strong desire to obtain a sustainable and approved solution, even though they have different political standpoints, and the decision to make is multifaceted in nature. The common understanding of their objective(s) was established during problem structuring activities in the middle investigation layer. The proxy objective was to make Svartån ready for swimming by 2010, when the chair of the urban planning board had promised to take a public swim in front of the city's old castle. The extended objective (which was subsequently pursued) was to obtain a sustainable long-term solution with increased water quality in general, in line with the EU water directive.

15.5 Problem Structuring and Workshops

When this proxy duality of objectives was discovered during the initial workshops, it was decided to separate the process into two stages. The first one concerned the formulation and refinement of the extended problem and the interaction between politicians and civil servants, while the second stage dealt with communication with the public and the final processing in the council. During the first stage, the ADL method stimulated interaction between politicians and civil servants continuously during the work process, partly through the joint workshops held at regular intervals. The following workshop scheme was used for the joint workshops:

Workshop no 1: An initial workshop, where both politicians and civil servants participated, with an introduction to multi-criteria decision analysis, the proposed work method, and the decision support tool.

Workshop no 2: A workshop with politicians, with the aim of identifying the political (main) criteria collectively and decide upon these.

Individual interview round no 1: Weights for the main criteria were elicited from each of the politicians involved.

Workshop no 3: A workshop with civil servants and experts to identify the *means* criteria of the *main* criteria (Keeney, 1992), identified by the politicians in workshop no 2.

Workshop no 4: A joint workshop with politicians and civil servants where the means criteria (identified by the civil servants) were presented, discussed and slightly modified.

Workshop no 5: A joint workshop with civil servants and experts in which the elicitation of interval-valued utility statements regarding the means criteria was initiated with *DecideIT*. The elicitation regarding the remaining means criteria was later completed by the civil servants with phone assistance by an expert in the decision software.

Workshop no 6: A joint workshop with politicians and civil servants where different possible measures were discussed. The initial nine alternatives were reduced into seven, following discussions during the workshop.

Individual interview round no 2: Weights were elicited on a second occasion from each of the politicians in order to see whether their initial preferences remained and also to acquire a scale factor.

Workshop no 7–8: Joint workshops to analyse and discuss the options in order to reach a decision.

The political criteria were collectively decided at WS2 led by a facilitator, where the politicians from the urban planning board were asked to present what they wanted to achieve with respect to the future of Svartån. The result of this workshop was the following criteria: practicability, economy/costs, ecological sustainability of the solution, nature/wildlife, water quality, impact on existing businesses, and bathing and swimming aspects. One important result of the criteria identification process was that the members of the urban planning board could, after some debate, agree on the fundamental purposes of making the river ready for swimming. It was concluded that the initial objective, the proxy objective to make Svartån ready for swimming by 2010, served rather as a symbol and a tangible result for the public and could therefore not be rejected. It was represented by the bathing and swimming aspects criterion, but during discussions the extended objective to obtain a sustainable long-term solution with increased water quality in general, was represented by other criteria, such as water quality, which mainly concerns drinking water, nature/wildlife and ecological sustainability of the solution. The civil servants identified the means criteria to measure each main (political) criterion (in WS3), which were confirmed by the politicians in a joint workshop (WS4). Thereafter, they compiled all their information regarding different possible measures and their corresponding effects, and, eventually, identified an unstructured set of loosely defined alternatives. The approach facilitated the work of identifying alternatives from the large set of possible measures (about forty) suggested by three major environment consultancy firms. These were specified further in a collaborative fashion in reference to nine possible alternatives. As a result of the extended objective becoming more important throughout the process, the two alternatives focused only on the ability to swim were disregarded. The following seven alternatives remained (after WS6) when decision modelling began:

Alt. 1 Attend to single sewers: The municipalities' environmental office would continue to make an inventory of single sewers (part of the sewer system had already been invented) and raises the requirements of the land owners with respect to taking care of sewers not fulfilling legal requirements. Priority will be given to the sewers upstream of the city.

Alt. 2 Attend to public sewers: Upstream of the city, there is a number of pump stations and public wastewater purification instalments. They separate impure wastewater into dikes and water bodies within the watershed. The respective instalments' possible effects on the water quality need to be investigated and taken care of.

Alt. 3 Digestion of stable manure and biogas installation: By allowing for stable manure to pass through the digestion chamber of a biogas installation, bacteria will die. From the installation, biogas together with bacteria-free slurry will be taken care of and used as energy production and manure respectively.

Alt. 4 Rain water measures: Measures in order to purify the rain water from bacteria may also decrease the nutrient content, heavy metals content, and petroleum content that travels to the river with rain water.

Alt. 5 Build wetlands: By allowing for drainage water from the surrounding fields to pass through larger wetland areas, the bacteria amount and nutrient content may be reduced. This also opens possibilities for an increase of the ecological multitude in the landscape.

Alt. 6 Attend to livestock farming: Shut out livestock grazing by the watercourse (legislate in order to prohibit farmers to allow grazing closer than a certain number of meters), as well as attend the farmers' treatment of manure.

Alt. 7 Vegetation zones and dikes in the fields: Build vegetation zones along the watercourses and dikes in the landscape. Attend drainage pipes and make them flow into buffering vegetation along the watercourses. At the same time attend the dissemination of manure.

15.6 Elicitation of Decision Data

Regardless of the particular *e*-democracy process used, there is a need of reliable elicitation mechanisms. Elicitation of decision data is necessary both with respect to the priorities of the politicians, as well as with respect to assessing the value of the feasible options. Thus, the elicitation was performed at two different criteria levels: (1) A higher abstraction criteria level regarding the fundamental objectives, referred to as the 'political criteria' indicating the values held by the politicians and (2) a technical criteria level regarding the means objectives representing the civil servants' views on different measures' values. An important feature of the process is that the politicians need to state their priorities with respect to the criteria. This was done by assessing criteria weights using a graphical assessment tool. The weights for the political criteria were elicited individually from the politicians using a two-step procedure. The first step took place early on in the process, right after the identification of the seven criteria, in order to initiate and motivate the decision-makers' reflections about their own preferences. The second occasion was later on in the process, when the decision makers had a better understanding of the problem, the different possible alternatives, and their own preferences.

Each decision maker used a graphical weight elicitation tool to supply their priority order for the criteria ($Cr_1, \ldots, Cr_7$). This was performed by first ranking them ordinally from most to least important, with ties allowed. After determining the priority order of the criteria, they were initially distributed equally along a graph, indicating that the magnitude of the differences between their relative importance were equal, i.e. that the magnitude of the difference between Cr_1 and Cr_2 was equal to the magnitude of the difference between Cr_2 and Cr_3, and so on. Thereafter, the decision makers were instructed to adjust the distances between the criteria in order to express their preferences regarding the magnitude of their differences, e.g., the decision maker could feel that the magnitude of the difference between two criteria should be smaller or larger, which was indicated by decreasing or increasing the distance between the two. In this fashion, we receive preference strength information regarding the magnitude of the differences between the criteria. The graphical elicitation method allowed the decision makers to be less precise since no exact values were required. The approach allowed them to adjust interactively the distances between the criteria until they felt that they had an adequate representation of their preferences regarding the magnitude of the differences among political criteria.

At the second step of the procedure, when the understanding of the problem had increased, the decision makers were asked to redo the procedure described above. They could have changed their view on what was more important for the decision, as beliefs and preferences are not static. At this later stage, the decision makers were also asked to express strength in their preference differences more explicitly. This was achieved by asking them to value their least important criterion in relation with the most important criterion, which received 100 points. Later, we could study the robustness of the preferences obtained by allowing for different widths of weight intervals encompassing the weights which was derived from the elicitation data. For the aggregation of weights, and, in particular, coping with different weight statements representing conflicting priorities, several methods have been proposed, see, e.g., Matsatsinis and Samaras (2001). In this case study, the following method was chosen to gain as much understanding of the process as possible. For each criterion, all individuals' distributions of weights were collected together by forming an interval embracing all weights, and a focal point, used later in the evaluation, was formed from the mean value of the weights. This simple technique, together with evaluating the decision using the individual weights for each politician, was used.

The elicitation at the second, technical criteria level regarding the values of the means criteria was initially performed by the civil servants with assistance of the analysts in WS 5. The civil servants had varied expertise and contributed with direct assessments, although not immediately on request, on the different values of the identified alternatives regarding each means criterion. These values were assessed in a direct fashion using intervals and point values on a calibrated scale [0, 10]. The decision makers thereafter confirmed these assessments when the valuations were demonstrated in WS6, where both politicians and civil servant representatives participated.

15.7 The Analysis Layer and Decision Frames

At the analysis layer, a *decision frame* represents a decision problem, and the idea is to collect the information obtained from the investigation layer into one single structure, enabling a set of techniques for decision evaluation and comparisons of the alternatives. This structure is filled in with user statements elicited from the politicians and experts in the workshop series outlined above, so that a decision model of the situation was created with the criteria and alternatives in a criteria hierarchy tree, shown in Fig. 15.1.

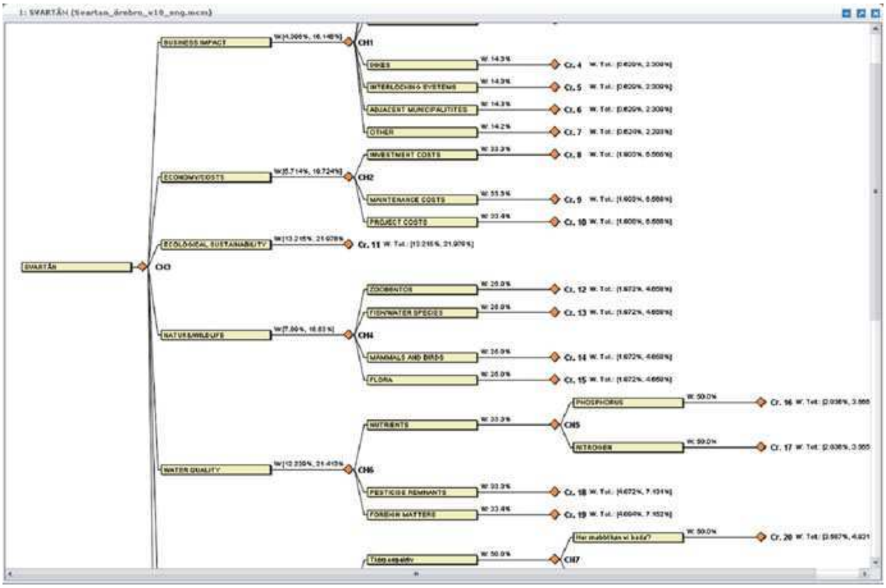


Fig. 15.1 Screenshot of decision software *Decide*IT holding the criteria hierarchy used in the case

The alternatives in the investigation layer are formally represented by consequence sets in the decision frame in the analysis layer. Once the criteria hierarchy with criteria and alternatives had been created as a result of workshops 2–4, numerical input (weights, values, probabilities) was entered as fixed numbers, intervals, or comparisons as desired, which was the issue for workshops 5–6. Such statements may also be mixed as appropriate. Thus, if no explicit values are available, a decision maker may rank alternatives (or consequences in the case of uncertain outcomes) as, e.g., equally preferred or as one being more preferred than the other by assigning comparative constraints. Sometimes, there may be an interval available for the difference between values rather than for the values themselves. Such information can be modelled in the tool and is labelled 'value relations'. For an example, see Fig. 15.2. It visualizes the input of the constraints $V(\text{Alt}_4) = V(\text{Alt}_2) + [2, 4]$ and $V(\text{Alt}_4) > V(\text{Alt}_3)$ generating the value hull of Alt_4, ${}^{h}V(\text{Alt}_4) = [7, 10]$.

Formally in the tool, these input statements are collected as linear constraints to the solution sets of the spaces spanned by the weight, value, and probability variables, respectively. These constraints may be both range constraints, i.e. constraints involving only one variable such as interval boundaries, and comparative constraints involving two variables.

For a regular decision tree with decision nodes, event nodes, and consequence nodes, there is one probability constraint set $\mathbf{P}$ and one value constraint set $\mathbf{V}$. For a multi-criteria model, as in the case here, there is also a weight constraint set $\mathbf{W}$. As the criteria model is in the form of a criteria hierarchy tree, the weight constraint sets is a union of local node constraint sets, so that $\mathbf{W} = \cup\mathbf{W}_i$, where each $\mathbf{W}_i$ is a

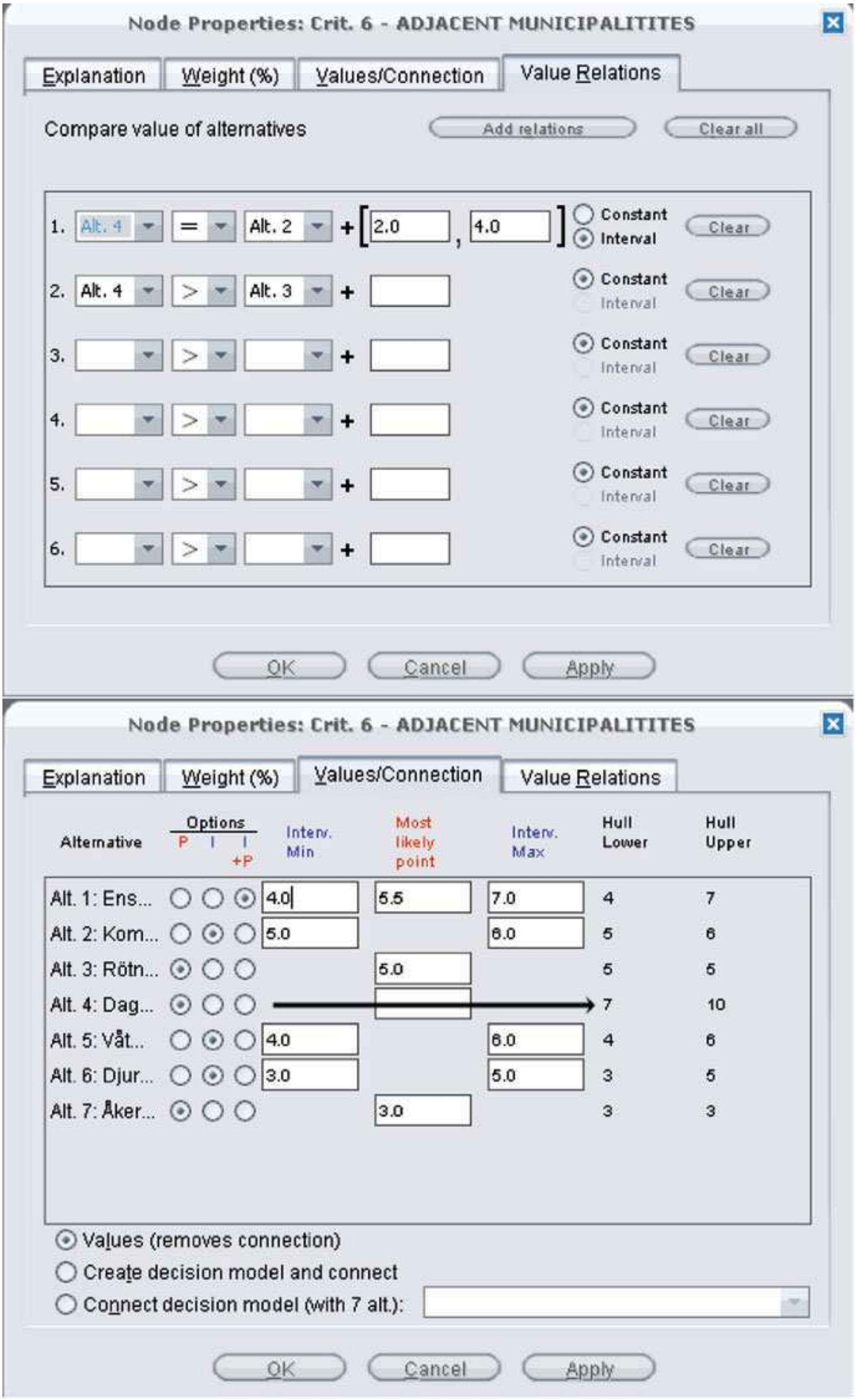


Fig. 15.2 Input of the constraints

local weight constraint set for a criterion node W_i. If probabilistic decision trees are present under some criteria, the probability constraint set shares the same properties as the weight constraint set. The value variables and related constraints are assigned to the alternatives of the model. For a decision tree, variables and constraints are assigned to the consequence nodes.

To further aid in the modelling of the problem, the *orthogonal hull* concept indicates to the decision maker which parts of the statements that are consistent with the information given so far. The decision information can be considered as constraints in the space formed by all decision variables. The (orthogonal) hull is then the projection of the constrained spaces onto each variable axis and can thus be seen as the meaningful interval boundaries (Danielson and Ekenberg, 2007). The same type of input is used for values, probabilities, and weights, although the normalization constraints $\boldsymbol{\Sigma} p_i = 1$ and $\boldsymbol{\Sigma} w_j = 1$ must not be violated. All input into the model is subject to consistency checks performed by the tool.

For each variable, there is also a *focal point*, which may be viewed as the 'most likely' or 'best representative' value for that variable. Hence, a focal point is a unique solution vector whose components for each dimension (variable) lies within the orthogonal hull. Given this, we calculate the *strength* of alternatives as a means for further discriminating the alternatives. The strength δ_{ij} simply denotes the difference in expected value, i.e. the expression $\mathbf{E}(A_i) - \mathbf{E}(A_j)$. For multi-criteria models, the expected value for each criterion is aggregated into a weighted sum of expected values for the entire decision problem. By denoting the expected value of an alternative A_i with respect to the kth criterion with ${}^k\mathbf{E}(A_i)$, this leads to an expression for the weighted strength $\sum_k w_k({}^k\mathbf{E}(A_i) - {}^k\mathbf{E}(A_j))$. In its most basic form (one-level decision tree) ${}^k\mathbf{E}(A_i)$ is reduced to $\sum_k p_{ik} \cdot v_{ik} - \sum_l p_{jl} \cdot v_{jl}$ over all consequences belonging to alternative A_i and A_j, respectively, such that p_{il} denotes the probability of the lth consequence, possibly occurring when choosing alternative A_i. Details on how this is computationally handled in the evaluation are found in Danielson and Ekenberg (2007) and Larsson et al. (2005). Hence, in the tool, probabilistic decision trees may be used alone for single-objective decision problems and can also be 'connected' at any time to a criterion leaf-node in the criteria tree as long as the initial alternatives in the probabilistic decision trees map one-to-one onto the alternative set in the multi-criteria tree.

An important feature of the process is the *sensitivity analysis*. This analysis attempted to highlight what information was the most critical for the obtained results and must therefore be subject to careful additional consideration. It also points which of the assessments that are too imprecise to be of any assistance in the discrimination of alternatives and thus should be made more accurate, thereby triggering and facilitating iteration in the process.

The embedded sensitivity analysis, through the concept of *contraction*, is performed by reducing the widths of the intervals (contraction) for the values and weights in the analysis model of the decision problem. The idea is to shrink the orthogonal hull while studying the stability of $\max\{\delta_{ij}\}$ at different contraction levels. The contraction level is indicated as a percentage: for a 100% level of contraction all orthogonal hull intervals have been reduced to their respective focal points. The contraction can be seen as cutting the hull from the extreme points (having a lower reliability or a lower degree of belief) towards the focal point, increasing the lowest permitted degree of belief. When dealing only with interval statements, this is quite simple, and more complicated when comparative constraints are involved. For a formal treatment, see Danielson (2004).

As a simple example, consider a decision alternative A_1 with four criteria g_1, g_2, g_3, and g_4, each assigned an interval weight of $w_i \in [0.2, 0.4]$, and interval-valued values $V_1(A_1) \in [10, 30]$, $V_2(A_1) \in [20, 40]$, $V_3(A_1) \in [0, 50]$, and $V_4(A_1) \in [50, 60]$ for each criterion, respectively. These interval statements will yield the corresponding orthogonal hulls, and the suggested focal points for the probability variables will be computed to 0.25 and for the value variables to 20, 30, 25, and 55, respectively. This leads to an expected value interval for A_1 of [16, 48], that is $\max\{\mathbf{W}(A_1)\} = 48$ and $\min\{\mathbf{W}(A_1)\} = 16$. Now, at a contraction level of 40%, the widths of the intervals from each orthogonal hull boundary and each focal point will be reduced by 40%. Denoting the weight hull intervals at a contraction level of l by ${}^{h}w_{il}$, these are obtained through

$$ {}^{h}w_{il} = [{}^{f}w_i - (1-l) \cdot |{}^{f}w_i - {}^{\min}w_i|,\ {}^{f}w_i + (1-l) \cdot |{}^{f}w_i - {}^{\max}w_i|] $$

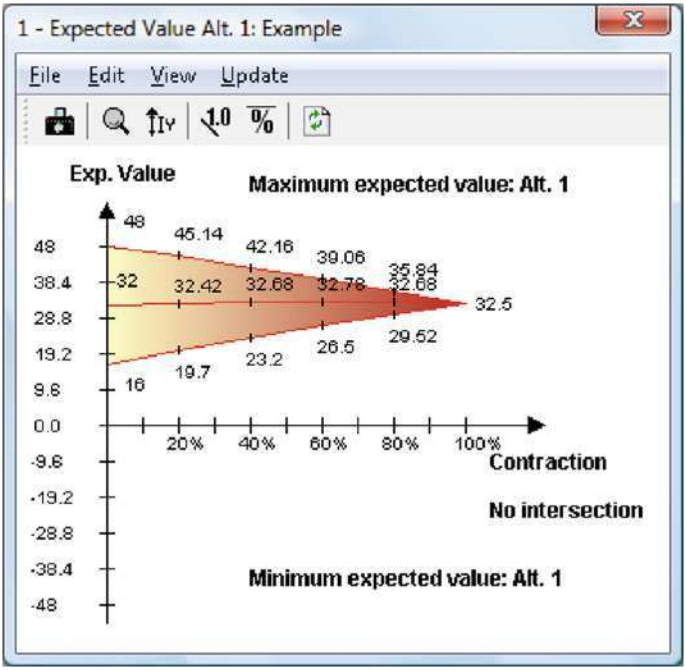


Fig. 15.3 Expected value graph for the simple decision alternative presented in the example above. Along the *horizontal axis*, we have the level of contraction and the *upper* and *lower graphed lines* show the minimum and maximum expected value for contraction levels ranging from 0 to 100%

where ${}^{f}w_i$ is the focal point for the variable w_i, ${}^{\min}w_i$ is the lower bound, and ${}^{\max}w_i$ is the upper bound for the same variable. For values and probabilities, the same formula applies. Now, $\min(\mathbf{W}(A_1))$ at a contraction level of 40% of the orthogonal hulls, is calculated as 23.2, as can be seen in the expected value graph in Fig. 15.3.

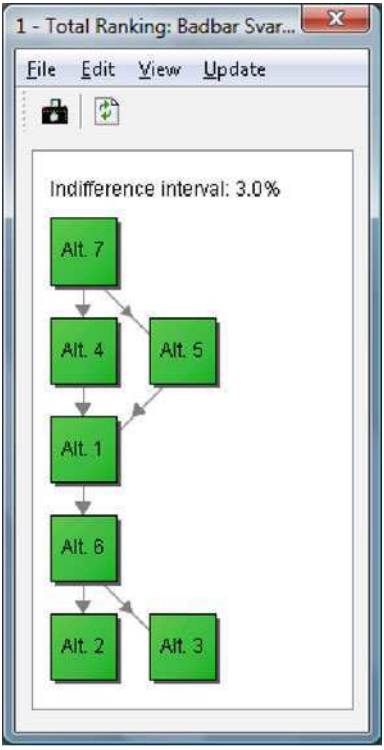
15.8 Analysis Results

Before initiating computational decision evaluations, alternatives found to be obviously inferior by information from the upper layers were removed from the decision process. The removal was confirmed by the stakeholder layer, and this was the case for two alternatives that clearly did not meet any objectives other than the initial proxy objectives. New alternatives may also be added at any time given a confirmation by the stakeholder layer, although this was not the case in this particular project. With respect to compromises, such did not need to be made in order to obtain a sufficient degree of support for the prevailing alternatives. There was a rather simple reason behind this: the civil servants deemed that vegetation zones along the watercourses and dikes in the landscape were both cheap as well as very effective with respect to the long term objectives of selecting a sustainable solution and reducing the amount of bacteria. Otherwise, compromises may be done by reducing the intervals of the weights and values. Major compromises must then be discussed in order to ensure that negotiating parties receive a fair distribution of them, if any, so that negotiations will not be perceived as having a lack of fairness.

The idea behind using the PDSS was to fit into the decision-making process already in place, enhancing rather than replacing the public – political – civil servants relations in the decision process.

After the appropriate number of layered process iterations had been completed, both the decision problem and the proposed courses of action were well-defined by the civil servants. This was then made available to the politicians for discussions, and later also as a basis for interaction with the public, where the rationale for the proposed actions will become accessible for the stakeholders. Of importance is that the evaluation results will only be interpreted as advice given, but the advice rest upon the priorities expressed by the politicians prior to the generation of alternatives. This led to effective workshops for alternative generation as well as for alternative removal and put focus on the overall objectives with respect to the river. Examples of ranking information used in workshops are total ordinal ranking (see Fig. 15.4) and cardinal ranking (see Fig. 15.5). The purpose was not to replace the political process but to support it and the process of interacting with the civil servants and the public in a structured and analytical fashion. In stage two, all interested parties will be given access to the information and they will be able to discuss the problem, assess the political process, and check, verify and criticize the decision based on the output documentation, which, because all consequences are clearly presented, shows how all the alternative courses of

Fig. 15.4 Total ranking of the alternatives derived from focal points of the input intervals



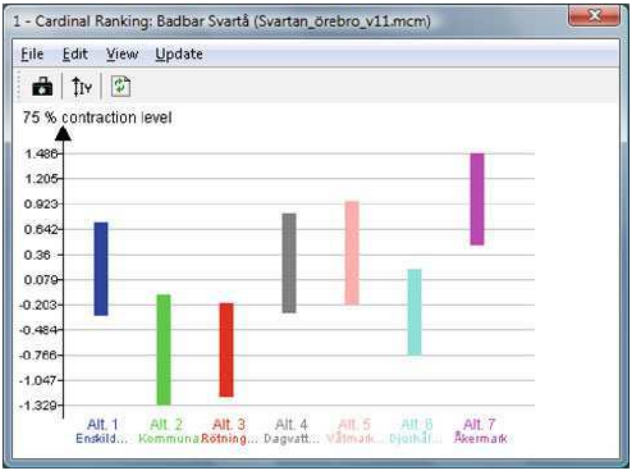


Fig. 15.5 Cardinal ranking of the seven options obtained from weights by a single politician using a contraction level of 75%

action were valued and handled. Hence, the democracy model of this particular case study is of a semi-thin model kind, since the public do not participate in all stages.

15.9 Conclusions

Based on the successful implementation of previous projects for participatory democracy supported with decision aid, we have implemented a transparent democratic decision process for decision making in the Swedish city of Örebro. A main challenge so far has been to suggest processes in conformity with common decision processes, but with a higher emphasis on accuracy and quality in the interaction between civil servants and the decision makers.

The process should be open to interests of various stakeholders, and allow for modelling of outcomes based on different preferences as well as contain a negotiation process where views can be adjusted with regard to calculated outcomes. On the other hand, available facts must be used to increase insights into the outcomes of applying different preferences. Therefore, the decision process must be iterative and there must be conflict resolution measures so as to allow participants to modify their views in several respects and at several check points. At the same time, facts and preferences must be kept apart as far as possible and be aggregated in a controlled manner.

The primary target group for the research results is policy makers, civil servants, and citizens at local levels. In the case study, a model for systematically informed democratic decision processes has been implemented consisting of the following elements:

- A process for systematic interaction between decision makers (politicians) and civil servants (in stage one).
- A system for including citizens' views and reporting on progress to the public (in stage two).
- A process for preparing and carrying out the preparations for the decision.
  The latter includes process models, structures, and tool supports for:
- Describing the alternative options available.
- Describing the criteria (perspectives) under which to view the alternatives.
- Describing the consequences of each alternative with respect to each criterion.
- A procedure that can evaluate and compare the alternatives, taking all relevant criteria into account while aiming at transparency and cost efficiency.

There are numerous benefits associated with democratic decision making using transparent decision support tools. The benefits range from better use of available resources, over fairer distribution of wealth, to transparency in allocation. The costs for complicated allocation problems can be brought down and the efficiency in allocation can be increased. From the view of the politicians and the civil servants, this leads to a structured process the objectives of decision makers are clearly communicated to civil servants, who then return the relevant facts surrounding the feasible options. As a next step, we will expand the involvement of representatives of the eventual audience. In stage two, where the external democracy aspects will be studied, the decision process and its results will be made available through a website, where all intermediate results of the project group, such as selected evaluation criteria and consequence analyses, will be included. The results of both stages will subsequently be applicable to other issues at the council and to other local governments facing similar issues. Furthermore, the results will be useful as well to emerging-economy countries and to developing countries, which face special problems considering information availability and transparency in decision processes, both within and outside of governments. For this purpose, we aim at continuing with an implementation in a developing country for the purpose of adapting the framework to a setting with different conditions. We will there invite a reference group from university and from one or two agencies working with municipalities and decision support systems in governmental settings. In addition, we will also recruit advisors from local and/or national governments and some authorities, from Sweden or other countries.

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Chapter 16
From Participatory to *e*-Participatory Budgets

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16.1 Introduction

Participatory budgets (PBs) are emerging as one paradigm for participation, especially at local level, see Sintomer et al. (2008). PBs constitute an attempt to allow citizens to have a word on the decision of how part of a public budget is spent, mainly in municipalities. They constitute a budget allocation approach based on dialogue and citizen participation, which diverges from the current predominant representative model. In a sense, PBs are transforming the idea of a representative democracy, in which the citizen's input is considered just at the moment of elections, to move closer to a participatory democracy, based on direct participation and debate.

Though several experiences have been described and are mentioned below, the most well known PB process comes from the city of Porto Alegre in Brazil. Despite the importance of this case, we note that PBs are becoming increasingly popular in many other places around the world. Recent reports indicate that more than 100 municipalities in Europe, covering more than 4 millions citizens are implementing PBs in one way or another, see Sintomer et al. (2008). The announcement of the UK government in year 2006 that all municipalities should implement PB experiences by 2012 is symptomatic in this respect (see Röcke, 2008). At this point, it is worth mentioning that PBs have been implemented by governing parties of all colors, from the left to the right.

The constant growth of PB experiences across Europe must be related with their benefits: greater legitimation of investment decisions; an approximation of investment decisions to citizens; making public investment decisions publicly; and greater transparency in public expenditure. There are, however, several criticisms to be made, stemming from the PBs undertaken so for. From an ICT point of view, we appreciate that, except for a few experiences which use discussion forums to collect

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electronically suggestions for project proposals as well as votes, there is little use of ICT: they are based on physical meetings, with preferences established through voting, very frequently by raising hands in public. From the point of view of the little decision technology employed, no formal modelling of citizen preferences is undertaken and no use of negotiation or group decision support tools is used. To sum up, little decision support methodology is used.

A general methodology for participatory budget elaboration support based on decision and negotiation principles has been introduced in Ríos and Ríos Insua (2008). In this chapter we describe a web based implementation that follows the general architecture in **Ríos Insua and French**, and a PB experiment conducted using it. This chapter is structured as follows. Section 16.2 presents some European PB experiences as well as the Porto Alegre case. In Section 16.3, we introduce an architecture to support the elaboration of a participatory budget. In Section 16.4, the architecture is illustrated with an experiment. We end up with some discussion.

16.2 A Critical Assessment of Participatory Budgets

Today, there are more than a hundred European cities, in countries such as France, Germany, Italy, Portugal, Spain or the UK, that have launched participatory budgeting practices. In the following we will briefly present some of them. Nevertheless, we shall start with the Porto Alegre experience, as many of them are based in this one.

16.2.1 Porto Alegre

Porto Alegre provides one of the most important PB examples and has become a paradigmatic reference for many other cities. Porto Alegre is the capital of Rio Grande do Sul, in Brasil. It has a population above one million and a half inhabitants. Until the beginning of the decade of the eighties, Porto Alegre increased its population in a short period of time, which generated instability and settled the third part of the inhabitants down in suburbs, lacking basic infrastructures. The Government decided the investments without taking into account the citizen's priorities. Furthermore, the city was facing several financial restrictions and no public works could be afforded by the government. As a consequence, the growth of the city was unbalanced.

When the Popular Front, led by Dutra and Genro, took over the government of the city in 1988, it tried different ways to provide more power to the citizens and change the priorities in public expenditure, approaching them to the less privileged classes. In this context, the first PB experiments took place in 1989, as a new way of elaborating the municipal budget. During the first 2 years, they went through a trial phase. From 1991, the PB became a more established process which started to mobilize an increasing number of citizens. In 2002, more than twenty eight thousand persons attended the meetings and regional assemblies. Since the PB started, its functioning has been improved, trying to solve various issues that have arisen.

Participation in Porto Alegre is organized through seventeen regions, defined according to geographic, social and community criteria. Also, to deal with non-local issues affecting the city as a whole and to allow citizens and organizations discuss and participate more globally, six assemblies around the following thematic areas were created:

- Urban development and environment.
- Transportation.
- Health and social care.
- Education, sports and spare time.
- Culture.
- Leisure and financial development and tax planning.

Every year, all citizens are invited to participate in the budget setting. At the beginning of the process, the administration presents a detailed report of the investment plan approved in the previous year, the degree of progress for the current year and the expected level of resources for investment for the next year. Then, meetings at the thematic and regional level take place, in which the population brings up their needs and establishes their priorities. In these meetings, delegates in regional and thematic councils are also elected for the Regional and Thematic Delegate Forum. At this time, also the Municipal Council of Government Plan and Budget is formed. The Delegate Forum is responsible for the analysis, definition, and prioritization of the works and services to be submitted to the Council. In addition, they have the responsibility of following up the public works in the investment plan. The technical staff, together with the government, participate in the meetings of the Municipal Council to discuss the works, as well as their cost and technical feasibility.

The investment resources are distributed among regions and thematic categories using a two step procedure which generates a budget matrix, specifying the amount of resources allocated to each region and thematic category. This procedure uses quantitative criteria and indicators, including the citizens' priorities established in the regional assemblies. In the first step, the available budget is distributed among thematic categories. At the regional assemblies, citizens vote on thematic priorities for investment in that region by ranking the top (four) ones, among the sixteen available thematic categories to choose from. The aggregation of votes at each regional assembly generates a list, ranking the four more important thematic priorities for that region. Thematic categories receive points from each region according to the priority ranking in that region. The available budget is then distributed among the thematic categories proportionally to the total points received from all regions. However, there are technical criteria that can enforce expenditures by legislation in these categories, ensuring that minimum percentages will be allocated e.g. to education or health care. This brings exceptions on the budget allocation formula and limitations to the popular will. At a second step, the budget allocated to each specific thematic category is distributed among the seventeen regions according to a formula combining three criteria:

- The total population of the region, so that the more populated areas receive more resources (weight two).
- The lack of services or infrastructure, so that poorer areas receive more (weight four).
- The thematic priority that has been given by citizens in each region (weight five).

The evaluation of the first two criteria is done by technical staff of the council, while the third is decided in regional meetings, through voting. The weight of a criterion indicates its importance in the allocation formula to distribute the thematic resources among regions. The more important is a criterion, the higher its weight. The total number of points a region receives under a specific thematic category is the sum of points received under each criterion, following the schedule in Table 16.1, multiplied by their criteria weight. The resources within a specific theme are then distributed among the regions proportional to the number of points each regions receive under this theme. This point scheme favours regions with higher needs in a theme, by giving them more points. Although more populated regions receive more points, as the population weight is lower that the weight associated to the criterion concerning region needs, regions with more citizens' needs will tend to receive more points and, therefore, more resources.

At the end of the process, the Investment Plan is subject to approval by the Municipal Council of the Government Plan and Budget. After the approval, the investment plan is sent by the executive power to the town delegates who discuss it, present amendments and, eventually, modify it. All this shows that the PB process in Porto Alegre is governed by a mix of direct and participatory democracy principles.

16.2.2 France

In 2002, the National Assembly approved the Democracy of Proximity Law that forced the creation of District Councils in all cities with population bigger than

Table 16.1 Budget matrix

Total regional population	≤25,000	1
Weight 2	25,001–45,000	2
	45,001–90,000	3
	>90,000	4
	≤14%	1
Lack of public services or infrastructures in the region	15–50%	2
	51–75%	3
Weight 4	>75%	4
Thematic priority given by the region	Fourth priority	1
Weight 5	Third priority	2
	Second priority	3
	First priority	4

80,000 inhabitants. In most cases, their role is merely advisory and links them closely to local institutions, so they do not have autonomy for the self-organization of citizens. Furthermore, they mostly deal with micro-local issues concerning the management of transportation, education, safety, etc. Citizens, gathered in open public assemblies, or through meetings with representatives, may participate in the decision of how to invest the available money, usually marginal amounts, to specific projects.

In this context, the first PB experiences appear as part of an effort to halt the decline of participation in local elections and counteract centralist tendencies. The French cases tend to have three general objectives, see Allegretti and Herzberg (2004):

- The enhancement of public management, increasing relations with citizens.
- Transform social relations, increasing the dialogue between citizens of different socio-economic background and strengthening conviviality and solidarity.
- Provide a complementary proposal, based on participatory democracy, to the Democracy of Proximity law.

We describe some experiences in France from recent years, see Allegretti and Herzberg (2004) for further details:

- Morsang-sur-Orge, is the most important experience in terms of citizen participation. It started in 1998 with the creation of district portfolios. In 2001, five thematic workshops were set up where residents and politicians discussed projects for the municipal budget. Participation is based on public assemblies where consensus decisions are made, taking into account just the people present in the meeting. Each council has full autonomy to decide how the resources are spent.
- An interesting example shows that the PB principles can be applied in different situations. OPAC, in Poitiers, is a public agency that manages all social buildings, a total of 7,500 lodgings. Since 2002, the organization has been demanding that tenants decide part of the investment projects. There are also six Local Planning Councils made up of an equal number of agency members and tenants.

16.2.3 Germany

Germany is one of the European countries with more PB experiments. Furthermore, it should be noted, as we shall see later, that in some cases ICT is widely used. The organization of German experiences tends to be split generally into three stages: first, the citizens receive the necessary information about the city's revenue and expenditures. The second phase consists of citizen consultations, which usually take place during public assemblies with the help of questionnaires, sometimes available through Internet. Finally, the last stage is the reporting phase, following the City Council vote on the budget. Various experiences vary around such general scheme. Some of the most important experiences, see Allegretti and Herzberg (2004), have been:

- In Rheinstetten, citizens participate in deciding how to improve the public services of the city. Information about them is presented at public meetings, and information points located in the public market. The consultation is carried out with the help of a questionnaire, which asks citizens about their point of view in order to understand the degree of satisfaction with public services and collect their proposals. Citizens can vote among the proposed projects, after which a public budget report information session takes place.
- Esslingen has set up Internet centres in the districts, where anyone can be trained on the use of this technology. On the basis of this initiative, in 2003 an Internet debate was launched about the local budget. The process was divided in two stages: the first one started up the debate, while the second discussion focused on specific issues, such as investments, taxes or energy saving. A moderator managed the process, mediating between citizens and the administration. Furthermore, the process included the possibility of an online chat with the Mayor and the Finance Councillor.

16.2.4 Italy

During the late sixties, political debates on citizen participation emerged in Italy, which motivated legislative changes at local government level. Law 278/76 led to the creation of Neighbourhood Councils with the aim of promoting local participation initiatives. In 1993, change introduced electoral law in the direct municipal elections, increasing the relation between citizens and politicians. Finally, in 2000 there was a new reform, the Consolidated Act for Local Authorities, which boosted the appearance of local level instruments to transform participation from a symbolic to an instrumental resource.

After the celebration of the first World Social Forum in 2001, Italians became aware of the Porto Alegre experience. Some municipalities, including Rome, formalized an interest in the adoption of PBs. Currently in Italy, there are more than twenty PB experiences. We shall describe two of the most important ones, see Allegretti and Herzberg (2004) for further details:

- In Pieve Emanuele, experiments in participatory processes have been gradually evolving since 1994 when, after years of corruption scandals it was necessary to regain the trust of citizens. In 2002, an experimental project on PBs started for 3 years (2003–2005). The process was structured in two stages: the first one consisted of six district public assemblies in which the citizens communicate their proposals; in the second phase, the administrators, technicians, and social organizations meet in Participatory Planning Boards, to analyse the citizen proposals, identify their technical and economic feasibility and, finally, elaborate a report including the proposals to be approved by the Council.
- Grottammare is the oldest of the Italian experiments. Until 2002, participation was limited to the creation of a list of proposals for the Council. Since 2003,

the town hall incorporated some methodologies from other Italian cities to support citizen participation at a wider level. The process is currently conducted in two phases: first, the Council technicians identify the needs of each district given by the citizens. In a second phase, residents express their budget priorities through voting sessions and, finally, they make a ranked list of priorities for the neighbourhood that the Council pledges to respect, guaranteeing at least the accomplishment of one priority per neighbourhood.

16.2.5 Spain

Many Spanish municipalities have developed PBs, although these experiences are few when compared with the number of municipalities. The first experiences began in 2001, in the cities of Cordoba, Puente Genil, Cabezas de San Juan and Rubi. Since then, more than twenty towns have implemented PBs. During this time only two of them have stopped their experiments, Rubi and Cabezas de San Juan, both coinciding with a change in local government after the elections in 2003, see Ganuza (2005) or Ganuza (2003). The most important experiences implemented in Spain in the last years are as follows:

- Cordoba, one of the first cities in Spain to elaborate a PB. In the 1980s, they adopted the first regulation where the District Council and the Council of Citizens Movement were created as agencies of local citizen participation. In 2000, the Federation of Neighbourhood Associations organized a meeting in which some councillors participated, together with some representatives of Porto Alegre. In 2001, Cordoba allowed citizens to participate directly in decisions related to public spending. The PB process in Cordoba is based on the Porto Alegre model.
- In 2003, Madrid began to design a model of participation to promote the incorporation of citizens in decision-making processes concerning municipal government investment. A main example of this, are the Plans of Action and Investment Planning see (Arenilla et al., 2007) for further details. This is a novel intervention programme that enables the development of various actions in those districts that have a greater territorial imbalance regarding the average of the city. In the process dominates a representative democracy model, where the associations responsible for making decisions on the definition of priority areas for investment. The role of citizens is limited to participation in consultation meetings to set priorities for action in the municipal districts.

16.2.6 United Kingdom

One of the main supporters of PBs in UK has been the NGO Community Pride Initiative (called Participatory Budgeting Unit in 2006), which since 2000 has developed an exchange programme with the Brazilian cities of Porto Alegre and

Recife, to learn from their experience, see Röcke (2008). Another factor contributing to the diffusion and discussion about PB was the creation in 2004 of the National Reference Group, which organized meetings several times a year where pilot projects are presented and discussed.

Despite these initiatives, until the 2007 only a few experiences of PB were implemented in UK, some of the first examples being the cities of Bradford, Sunderland, Newcastle and Salford. However, after this year PBs increased significantly, mainly due to the support shown by the Secretary of State for Communities and Local Government, Hazel Blears, who has developed a "national strategy" that expected the introduction of PB by 2012 by every local authority area. We should emphasize that UK is the only European country which includes PB in the national government's agenda. Two of the more relevant PB experiences have been:

- In Bradford, several PBs have been implemented over the last few years. An example of them took place in 2006 in Keighley, see Blakey (2007). The process secured a total of £130,000 to be spent in neighbourhood renewal, in relatively deprived areas, where citizens decided in which projects to invest the money. It was structured into two phases: first, in a consultation phase, the residents are invited to public meetings in which they send their proposals. Also, the citizens could communicate and prioritize their needs through questionnaires in individual interviews. In the second stage (Decision Day), the participants had 3 min to present their projects to other participants, who could vote it. Votes were counted when all presentations finished, and finally, the projects with highest score were included in the final budget.
- In Salford the first PB experience was promoted by the Labour government, with the support of Community Pride; see Sintomer (2004). The process began with consultation meetings in which all citizens were invited to present their proposals on issues such as the budget, the quality of public services, and taxes. The citizens also sent their proposals by post or online; see Pineda and Fernandez (2005). When the meetings finish, the City Council has to decide how to spend the budget using a resource distribution matrix: it mediates, through weightings and indicators, between the needs expressed by citizens and the objective needs of an area. Thus, even if citizens do not participate directly in decision making, their views will influence the final result.

16.2.7 Assessment

Through the analysis of the European experiences, described above, we have observed that, first, the PB process existence and success depends on the attitude of politicians. In this context, we have noted that although PBs are outside political ideologies, the majority of PBs initiatives in Europe have been supported by left wing parties, see Ganuza (2005). Furthermore, another key issue for the success of PB is the existence of social support, as in Albacete (Spain).

There are, however, several criticisms to be made stemming from the experiences undertaken in such processes. From the conceptual point of view, we should stress that participation is frequently limited to a small fraction of the population, in part against the idea of participation. Most of participatory budget initiatives are based on discussion and physical meetings within an assembly system in which preferences are usually established through voting, very frequently just by raising hands, with the potential disadvantage for people with worse communication skills. Furthermore, those who lose the advantages they had before participatory budgets were implemented, have a tendency to sabotage them. Thus, it is said that participatory budget experiences have been characterized by conflict, due to the large variety of groups with different interests that take part in it. This is not necessarily bad, as long as we have methodologies to manage such conflict. Actually, despite the popularity of Web 2.0 and social networks, only few experiences have used ICT to support the PB process. From the point of view of the little decision technology employed, no problem structuring tools are used, no formal modelling or quantification of the intensity of citizen's preferences is undertaken and no formal negotiation or group decision support tools are used, except for those based on voting. In part for that reason, citizens tend to focus more on the solution of their local problems, without a global vision, proposing little more than the re-paving or the lightening of some streets or small sewer and water projects as local public works. To sum up, there is little decision support methodology available. This is a main issue to involve participants from different age groups, as the young, for instance, use social networks every day.

Another problem has to do with unclear procedures for prioritization of proposals, which might weaken the credibility of the process. For instance, in some German cases, citizens remain doubtful about the real impact of their participation, because they often do not know why some suggestions are accepted, while others are rejected. This may lead to frustration and lower the degree of mobilization for the process.

16.3 An Architecture for *e*-Participatory Budget Formation Support

We describe now an architecture adapted from that described in **Ríos Insua and French**, that implements mostly the methodology described in Ríos and Ríos Insua (2008). The goal of our architecture is to provide a technological platform with innovative tools and techniques facilitating electronic participation services, and encouraging the use of ICT, possibly increasing citizen satisfaction, as well as transparency in the budget decision making process.

Our architecture is generic in that it allows deleting or repeating stages to adapt the system to each specific participatory budget process. The methodology implemented breaks down the participatory budget elaboration process in phases with specific purposes: budget preparation, discussion and consolidation, preference elicitation, negotiation, voting and post-settlement. We describe now our architecture, divided into modules, which support each of these phases. In this context, we distinguish three basic user profiles:

- The problem owner is the entity which aims at solving a participatory budget problem, structures and publishes it. Typically, it would be the City Council represented by the mayor.
- The participant, which provides input to the participatory budget decision process, that is, their opinions and preferences about which projects to include in the budget. They would be the citizens, perhaps represented by a sample of them or by elected representatives.
- The administrator, who takes technical care of the process development: supporting the problem owner structuring the problem, providing access rights to participants, defining the time windows for various phases, and, looking after the whole process security.

The architecture, see Fig. 16.1, guides the administrator, on behalf of the problem owner and the participants in the participatory budget elaboration process, following a protocol, based on the phases that we have mentioned. At any time, the action that each agent may carry out will depend on his previous action on the system and the actions of the rest of agents. As an example, none of the participants may communicate his preferences to the system until the administrator has finished the

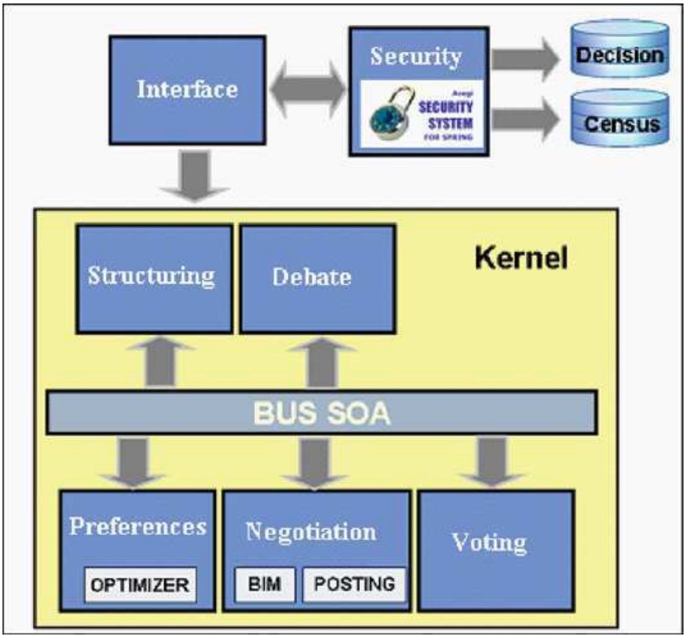

Fig. 16.1 Architecture

budget preparation phase. The process status at any moment is defined based on the actions carried out by the agents until that moment.

The architecture has been implemented with Java/J2EE, Open Source, see Weber (2004), development technologies (Spring, JSF, Hibernate, Acegi, Maven, Subversion, etc.). From the web technologies point of view, our architecture has been configured as Service Oriented Architecture (SOA). Thus, it is possible to adopt the Software As a Service (SaaS) philosophy, Software as a Service, eliminating the need to install and run the application on the customer's own computer because the application can be hosted as a service provided to customers across the Internet. SaaS can also conceivably reduce the up-front expense of software purchases, through less costly, on-demand pricing. Furthermore, the architecture intends to take a further step in the evolution of Web 2.0, because with it the citizens not only can communicate with others, or express their views, through social networks, blog, but also they will have the opportunity to participate and decide, to enhance transparency in decision making and, possibly, increase their satisfaction.

A relational database management system enables to store and manage information concerning the participatory budget elaboration process. Another database contains the information of all participants, their roles, their permissions, etc... Furthermore, the system has a web based user's interface.

We describe now the main system modules included in our architecture.

16.3.1 Security Module

The security module is responsible for verifying that users are registered in the application. To login into the system the users must authenticate themselves using a private password. The system, using Acegi technology, verifies that the user is in the database and has permission to participate. Acegi Security is an open source project that provides comprehensive authentication and authorization services for enterprise applications based on the Spring framework. Then, the system assigns the role that the participant plays and what that user can do within the system depending on his role. This module allows for identification of participants and definition of their access level at each stage of the process. The system would allow the incorporation of participants from a database, for example associated with a census. For those municipalities lacking those data or willing to accept other participants, we facilitate that potential participants send an electronic request to participate in a created budget problem. The requests are received by the problem owner that, with the help of the administrator, will accept or reject them.

16.3.2 Interface

To facilitate its use and mitigate the digital divide, the interface is graphical and user friendly. It meets all conditions and satisfies the web accessibility standards for people with disabilities.

16.3.3 Problem-Structuring Module

The architecture includes a module that allows the structuring of the participatory budget problem. Only the administrator, on behalf of the problem owner, may access this module. We assume that an initial list of project proposals and criteria is generated by the municipal government supported by the municipal technical staff. The citizens will use that initial structure to explore issues of interest concerning the problem. This module allows for:

- Define and structure the criteria or attributes to evaluate the project proposals by the participants. The name and scale measurement of each criterion should be specified.
- Define project proposals, including their names, a description of each one, the specification of their associated costs and their evaluations with respect to one criterion, that is, their levels in all attributes.
- Specify the available budget, to determine the budget constraint, together with other problem constraints, should there be additional ones, such as dependencies between projects or incompatible projects. For instance, a hospital parking cannot be built until the hospital has not been built.

The participants will not have access to that problem information until the problem is published by the administrator, allowing authorized citizens to participate in its discussion and formation. To do so, it is necessary that the administrator fills in a form specifying general features of the participatory budget elaboration process including:

- Time intervals for the debate and negotiation phases.
- The deadline for the preference communication phase.
- Percentage of participants who have to agree with an offer in the negotiation phase in order that it will be implemented as a group decision.
- Time interval in which participants can vote if they finally reach the voting phase and also the voting rule to do it. To select the voting rule, the problem owner must introduce several parameters such as the number of projects that a participant can vote, or the number of points they can give to each project, depending of the voting rule chosen.

16.3.4 Debating Module

When the problem owner has published it, authorized participants receive an *e*-mail with a login and a password, which invite them to participate in the budget formation. Once the problem has been published, the citizens can participate in the consolidation of the final list of proposals through an electronic forum supervised by the technical staff. Thus, citizens and stakeholders can extend the set of alternatives by proposing new possible projects. Citizens may also propose new attributes that reflect their objectives which have not been considered in the budget preparation phase. This module allows citizens and stakeholders to express their opinions and discuss by sending messages concerning adding, changing or deleting criteria or projects. The module allows the administrator on behalf of the problem owner, possibly helped by a decision analyst team, to:

- Moderate the forum and define forum access levels of participants.
- Decide the inclusion of new project proposals or criteria, if necessary, delete or change some of them.

16.3.5 Preference Communication Module

When the debating phase finishes, citizens are invited to evaluate privately and confidentially the final list of proposals against the given criteria based on their preferences. Participants receive an email communicating that they are expected to provide their preferences before a deadline. The system includes a module that allows participants to build their preference models within a given time frame. In that time window, the problem owner will not be able to modify any problem information, but will have access to the percentage of participants who have already communicated their preferences.

This is a very technical module, though we have built it in a very user friendly way. We assume that any user (citizen) may build his own value function. Without loss of much generality, we assume that the user's preferences may be initially modeled through a weighted additive value function. Therefore, they must quantify their preferences over the levels of each attribute and give weights to the additive value function, see Keeney and Raiffa (1976) or French and Ríos Insua (2000) for details. In the structuring module, the problem owner has specified the basic properties of the (multiple) attributes: number of attributes, their scale and range. It is assumed that all participants will share these attributes to measure project performance. Some participants may disregard some of the attributes, e.g., by giving them zero weight.

In this module, each user will assess his value function privately and communicate it to the system. The system will guide participants in their elicitation preference assignments, allowing for:

- *Assessment of each component value function*. If the attribute is measured with an objective numerical scale, participants can use a direct method to assess the value function over the levels of that attribute. The participants must communicate first whether the objective is to minimize or maximize that attribute, assigning their worst and best values. Later, participants must determine three points of the value function and the final value function for this attribute is estimated through linear interpolation.
- *Assessment of the additive value function weights*. A direct method is used to elicit the weights. The participants must introduce the weight for each attribute, giving a higher weight to those which they consider more important.

- *Consistency checking*. Once a participant assesses his value function, participant's projects values are computed and shown on a scale from 0 to 100, listed in decreasing value order. To validate user's preferences, users can change their projects preference values before the preference communication phase finishes.
- *Saving the value function for later purposes*.

Once the preferences of a participant are assessed, the system can compute privately his evaluation of each possible budget as well as his preferred budget. For that purpose, the system includes a submodule that allows users to evaluate feasible budgets based on his value function and obtain his preferred budget solving the corresponding optimization problem. To do this, the system calculates all feasible budgets and returns the budget with higher utility value for this participant. After the preference communication phase finishes, the system verifies if all participants who have communicated their preferences prefer the same budget. If this is not the case, the system proceeds to the negotiating phase to try to reach an agreement. An *e*-mail is sent to the participants to inform them that the negotiation has just started.

16.3.6 Negotiating Module

This module supports a multiparty negotiation dubbed as POSTING, see Ríos and Ríos Insua (2008), in which participants are allowed to make offers proposing in which projects to spend the budget and discuss them through a forum. Participants can vote for or against each proposed offer. The offer with highest percentage of acceptance among participants will be implemented if this percentage is sufficiently high before a negotiation deadline. Otherwise, participants will move on to the voting phase.

Furthermore, the module could be used if the system detects that a solution is dominated. In this case, participants have the option of renegotiating it by starting the negotiations from the dominated budget solution as disagreement point, using the balanced increment method (Ríos and Ríos Insua, 2008).

16.3.7 Voting Module

As it is conceivable that participants may not reach an agreement on a budget in the negotiation phase our system includes a voting module, which permits the design of a voting session, with several voting rules available and its execution, such as Borda Count, approval voting, majority rule or cumulative voting.

Participants receive an *e*-mail inviting them to vote in a time window. Participants will be able to vote via the web system in that time frame. Although this module implements several voting rules, we recommend using approval voting to compute a winning budget. In this case, participants will provide one vote to as many projects as they want. To facilitate this task, the system presents the projects ordered according to the participant's values communicated in the preference communication phase. The module allows them to modify their vote as long as the voting session not finished. Once the voting session finishes, the projects are ordered by their number of votes. Then, the winning budget is computed, as the subset of projects satisfying the problem constraints. To do so, the projects, following the previous voting order, are added to the voting solution whenever its inclusion in the partial voting solution does not exceed the available budget and the remaining problem constraints can be satisfied. Finally, the module sends an email to all the participants with the results.

16.4 An Experiment

We have conducted our experiment within the above framework with a small group of citizens who wanted to participate in deciding in which neighborhood renewal projects proposals spend an amount of 2 million Euros.

A preliminary study was carried out by technical staff to identify possible proposals. The sum of the costs of the initial proposals was higher than the available budget. The proposals were also subject to other constraints, in addition to the budgetary constraint. As an example, there were several projects for same purpose, not being necessary more than one of them in the final budget. This preliminary study also identified appropriate criteria so that participants could evaluate proposals in view of these criteria. The technical staff was aided by us in the task of choosing criteria in order to structure them.

The initial draft of the budget problem was formally debated with citizens who wanted to participate, including a brainstorming process to extend the set of proposals. This process was carried out through an online debate. Participants proposed new projects and the criteria were discussed guided by a decision analyst, to consolidate the final list of proposals and criteria, which included seventeen proposals shown in Table 16.2 and the following two constraints in addition to the budget constraint.

- As the Sports and Sports Center projects are for the same purpose, we shall not include more than one of them in the final budget.
- As the proposals of children, senior and dog areas in the park depend on the actual existence of the park, we shall be able to include the three above only if the last one is included in the final budget.

Finally, the proposals were assessed in terms of the following five criteria:

- Cost, in Euros.
- Effectiveness of the considered project defined by: Number of beneficiaries/Number of needy.
- Coverage of the considered project: Number of beneficiaries/Total population.
- Profitability of the project as the difference between income and maintenance.
- Total cost of project in thousand Euros, over the years (as some projects are multiyear).

Table 16.2 Proposals performance against the criteria

	Criteria				
Proposals	Effectiveness	Coverage	Profitability	Total cost	Cost
Park	0.75	0.45	−20	400	310
Children area	0.75	0.45	0	25	202
Senior area	0.35	0.25	0	15	228
Sports	0.75	0.4	0	25	125
Dog area	0.75	0.1	−10	10	71
Bike line	1	0.2	0	80	83
Sport centre	0.75	0.6	100	2, 100	805
Senior centre	0.8	0.9	−100	350	310
Internet centre	0.75	0.83	−15	140	283
Library	1	0.5	−33	1, 200	370
Water	1	1	−50	300	160
Trees	1	1	−30	150	75
Asphalt	0.3	0.3	200	10	140
Immigration	1	0.15	−50	100	205
School	1	0.6	−120	500	372
Security	1	1	−150	120	215
Cleaning	0.9	0.8	0	100	125

The value function of each of the sixteen individuals who participated was elicited in the preference communication phase. A weighted additive value function model with a common set of attributes was assumed and it was elicited through the direct method.

The problem has 29,249 feasible budgets. In the negotiation phase most participants sent their offers, but no offer reached sufficiently high acceptance. The offer with more favour votes obtained a rate of 55% acceptance, away from 80% necessary for agreement. Then we ran a voting session through approval voting over the proposals. This session had a participation rate of 63%. The final budget contains the projects in Table 16.3.

Table 16.3 Final budget

Proposals	Cost (in thousand Euros)
Trees	75
Internet centre	283
Cleaning	125
Asphalt	140
Water	160
Park	310
Sports	125
Security	215
Library	370
Bike line	83
Dog area	71

16.5 Conclusions

We have described an architecture which is a web-services intermediary system aimed at supporting groups in the elaboration of a budget. Rather than using physical meetings with voting mechanisms, our architecture promotes virtual meetings in which participants can extend the set of alternatives and explore the budget consequences. The architecture supports negotiation methods such as POSTING and the balanced increment method (BIM), but other multilateral negotiation methods could be implemented. If negotiations end up without an agreement, the voting module can be used to decide the budget.

The architecture illustrates how we might support groups to make decisions using ICT and decision technologies in the area of participatory budgets. We have also illustrated with an ad hoc implementation of the general architecture presented in Chapter 1 to solve generic decision-making problems how that architecture, rather than using new technologies to facilitate standard political decision-making mechanisms, would allow more participation, a more informed and transparent decision, and, even, a more consensual approach to transform current democratic processes.

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Chapter 17
Internet Voting in Estonia

Ülle Madise and Epp Maaten

17.1 Introduction

Estonia is widely credited to be a pioneer country in *e*-governance. According to The Global Information Technology Report 2008–2009, Estonia shares with Japan the 17th–18th place amongst 134 countries, directly after UK and Austria and before France and Germany. The use of electronic channels for different services is steadily widening in the country and different *e*-services are provided both by the public and the private sector. 63% of Estonian households have a computer at home connected to the Internet (Statistics Estonia, 2009). The eagerness with which the Estonians apply new IT solutions clearly points to a high level of *e*-readiness of the people.

While in many states, the first step towards some form of automated vote was to use voting machines in polling stations in order to facilitate voting or counting, in Estonia, from the beginning, there was the aim of creating conditions for public remote Internet voting (Drechsler and Madise, 2004).

Internet voting provides new opportunities to improve the electoral process, but it also presents new challenges. In particular, it is critical that I-voting is introduced in a manner that safeguards the transparency of elections, a fundamental democratic principle. I-voting, like other changes in the mechanisms used to capture votes – from paper ballots to voting machines – is a technology that changes the direct means of participation but not the nature of democracy itself. Thus, it has been a challenge for Estonia to integrate this new technological solution into the old traditions of voting.

17.2 Why Internet Voting?

The explosion of the Internet in the late 1990s led many to speculate about the possibility of using this new public channel to improve the efficiency, effectiveness,

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D. Ríos Insua, S. French (eds.), *e-Democracy*, Advances in Group Decision and Negotiation 5, DOI 10.1007/978-90-481-9045-4_17,

and legitimacy of democratic elections. We have come to the new era in which Internet is an integral part of everyday life and the main information channel for a growing number of citizens. Drechsler is probably right when he states, "[t] he impulse to continually upgrade information and communication technology is so irresistible that much of the world will follow Estonia's I-voting example. It is the future of politics, notwithstanding the warnings of people such as Internet theorist Manuel Castells, who contends that I-voting poses risks to democratic legitimacy." Drechsler, (2006) The declared aim of the launching of online voting in Estonia was to increase voter turnout, which perhaps could be described more realistically as widening access possibilities and stopping the decrease in participation. The participation rate at local government council elections in Estonia is usually ~50% and at parliamentary elections ~10% higher. Voter turnout did never exceed 70%, even at the 1992 constitutional referendum. By facilitating electoral participation, it seemed likely that voter turnout, and hence the overall legitimacy of the results, would improve. Another reason behind the I-voting project was the wish of exploiting the existing infrastructure more efficiently. The widespread use of the national *e*-ID card was vital for starting the Internet voting project, as only *e*-ID card owners had the option of voting through the Internet. According to most recent survey 82% of Estonian residents, aged 15–74, possess *e*-ID-cards (TNS Emor, 2008); thus, most of eligible voters (less than 1 Million) hold the card already.

A long-term purpose of the Internet voting project was to raise the cost efficiency of the elections. Currently there are 10 different voting procedures allowed in Estonia: advance poll with paper ballot inside and outside the polling station of voters' place of permanent residence from 6 to 4 days before election day; postal voting from abroad; voting at the Estonian Embassies in foreign states; home voting on election day; voting in custodial institutions and hospitals; voting on an Estonian ship, electronic voting from 10 to 4 days before election day and voting with paper-ballot on election day. At local elections not all of them are allowed. It would be possible to replace voting from foreign countries and may be even voting outside one's home polling station with Internet voting in the near future. In 6 years from the development phase to a double full-scale implementation the National Electoral Committee (NEC) spent less than €500,000, not including the investments already made for the basic infrastructure. Had there been no national population register – used as voters' register – nor an authentication system using *e*-ID cards, Internet voting in Estonia would have been too costly. The Public Key Infrastructure, the digital signature, and the existing process of authentication have served as absolute prerequisites for the creation of an efficient *e*-country (Maaten, 2007).

17.3 Project Management

In 2001, discussions among political and academic groups started about whether or not Estonia should introduce Internet voting. At the same time, the Ministry of Justice announced intentions to introduce Internet Voting as soon as possible.

In order to evaluate the idea, two reports were commissioned by the government: 'Analysis of implementation options of *e*-voting' (Lipmaa and Mürk, April 2001) and '*E*-voting in Estonia: Analysis of Options' (Tammet and Krosing, October 2001).

A political agreement was reached in 2002, and in 2003 the NEC started the electronic voting project. At the beginning of the project, the NEC involved as many IT security specialists as possible to elaborate a commonly acceptable approach and, thereby, to raise public trust in Internet voting. Good cooperation between different parties, public or private, was crucial in launching the successful and apolitical I-voting project.

I-voting project's executive group was formed by NEC, a project leader was elected and the roles between the NEC, executive group and project leader were distributed. In accordance with the project organization, the NEC approved the more relevant decisions. The task of the executive group was to make proposals and recommendations to the Committee and control the achieving of set objectives. The project leader was in charge of the implementation of the project, he summoned project groups formed by experts upon necessity, directed their work and checked the results.

At this stage, the I-voting concept was essentially complete. After that the security analysis of the concept was carried out by a working group formed of IT security specialists. Proceeding from the recommendations of the security analysis, changes were made to the concept and presented the document titled 'General Description of Estonia's *e*-Voting Project'.

Early in 2004, the technical specification of I-voting software was produced. Together with the security analysis, it was required to announce the public procurement for I-voting software. In March 2004, three tenders were submitted and the NEC chose the offer of Cybernetica Ltd. In autumn, the software was tested and ready for the first public pilot. Pilot, which was offering the possibility of I-voting in a polling of Tallinn residents, took place on 24–30 January 2005. 703 voters participated and 697 votes were counted. The system worked without failures. After the pilot was completed and a source code audit conducted, the I-voting system seemed in place and ready to be used in the local elections of Autumn 2005.

17.4 Creating the Legal Basis

17.4.1 Parliamentary Debates About I-voting

The scope of the parliamentary debate before launching I-voting was quite wide, ranging from clear ideological questions to detailed technological issues, see about the genesis of the Estonian I-voting project with references to the minutes of *Riigikogu* plenary sessions, party structure etc in Drechsler and Madise, (2004). The most discussed question was the exact meaning and purpose of the principle of secrecy. Other important questions were the digital divide and the value of the ritual of walking into a polling station.

In Estonia, as well as in many other countries that have created and allowed postal voting, advance voting and other supplementary voting methods, voting at a polling division has virtually lost its significance as a ritual transforming people into a nation-state and the carriers of sovereign nationhood (compare with Monnoyer-Smith, 2006). The rhetorical question of the opponents of I-voting in the *Riigikogu* was in a way emblematic: "Are we totally sinking into the liberal swamp?" This question was probably inspired by the I-voting supporters' assumption that the State must trust people and, if possible, not interfere with any of their decisions.

In the discussion about introduction of I-voting classical arguments about conformity of the I-voting with the principles of fair elections including reliability of electronic voting systems were changed, whereby one of typical arguments against I-voting was that people who have no commitment to go to the polling station to execute their citizen's duty, should not participate in governing at all, which contradicts the axiom that the higher the turnout, the better.

A possible lack of legitimacy of the election results could result from following:

- The individual I-voting procedure can not be supervised by authorities or observed in a traditional way. Therefore, massive buying and selling of votes as well exercise of other influence or pressure on the voter are possible;
- The people themselves cannot verify I-voting results, and people need to have an absolute faith in the accuracy, honesty and security of the whole electoral system (people, software, hardware). For people who didn't program the system, the operations of the computers can be verified only by knowing the input and comparing the expected with the actual output. Under a secret ballot system, there is no known input, nor is there any expected output with which to compare electoral results (Madise and Martens, 2006).

Although the risks mentioned above are handled, one should take into account that it is always possible to threaten legitimacy of the voting result without any objective cause. It is likely that while deciding whether to support electronic voting, political parties took into account the potential effect of remote Internet voting over their election results. Parties suppose that I-voting brings persons to vote who would by traditional means not participate, and additional votes will not be distributed proportionally amongst political parties. So it seems likely that increased turnout changes the share of votes between political parties (Madise, 2008). Of course such kinds of considerations contradict to the principle of universal suffrage.

17.4.2 Teleological Interpretation of the Principle of Secrecy

According to the Estonian Constitution members of the *Riigikogu,* as well as local government councils shall be elected in free, general, equal and direct elections, and voting shall be secret. There is no special regulation for I-voting in the constitution.

The secrecy of voting has traditionally been viewed in Estonia as the right and obligation to cast one's vote alone in a voting booth. In the case of Internet voting, the state is not in a position to secure the privacy aspect of the procedure. Legislators proceeded from the interpretation of the Constitution according to which secrecy of voting, drawing on its two sub-principles – private proceeding of voting and anonymity of vote – is required to ensure free voting and is not an objective per se.

The voter's right to anonymity during the counting of the votes is guaranteed to the extent to which this can be secured in the case of absentee ballots by mail; the so-called "system of two envelopes" used for absentee ballots by mail is both reliable and easy to understand for I-voters (see Section 17.5.2).

Remote Internet voting requires rethinking the privacy principle. The principle of privacy, is there to protect an individual from any pressure or influence against her or his free expression of political preference. Such teleological approach to the constitution was the basis of the I-voting provisions from the very beginning of the whole project. In addition to the teleological interpretation of the Constitution, the Ministry of Justice, led by the liberal Reform Party, based provisions enabling Internet voting on the premise that the state has to trust the individual and avoid, whenever possible, interference with decision making at the individual level. The individual has to be aware of risks, i.e. technical risks, and he or she has to have the right to decide whether or not to use the Internet voting opportunity (Drechsler and Madise, 2004).

This teleological interpretation of the principle of secrecy is clearly divergent from the traditional approach generally adopted in the scholarly literature. For instance, Buchstein (2004) remarks that: "Mandatory secrecy is a principle which goes beyond constitutional law, its fundaments are based on the idea of auto-paternalism and it is understood as a mechanism of self-binding of autonomous citizens in order to avoid situations of external pressure or corruption. In this concept, it is not the individual him- or herself, but a warranted outside agent or authority – normally the state – that is responsible for providing the necessary means to allow for the secret ballot."

In Estonia, unlike in some countries, the fact whether a person entitled to vote did participate in voting or not, is not regarded as a part of the principle of secrecy. The voter lists that contain information about participation and chosen voting method are preserved in an archive and can be used for research purposes. Researchers have made use of this possibility, including for the I-voting survey, what unfortunately weakened somewhat the public trust against I-voting. The fact that the official questioner had knowledge about the actual fact of I-voting made some people suspect about the secrecy of their voting decision. These suspicions were leaked in public media but they were more or less kept unnoticed. The explanation was that voters' lists have always had according information about who participated and what voting method was used. The voting decision itself has always been secret.

17.4.3 The Right to Change the I-vote as a Required Guarantee for Free Elections

In order to guarantee the freedom of voting, I-voters were granted the right to replace the vote cast on the Internet by another I-vote or a paper ballot. However, this could be done only within the advance polling days. In case of several I-votes, only the last one is counted; in case of contest between I-vote and paper ballot, the paper ballot was counted. If several paper-ballots are cast, all votes are declared invalid. Thus, the 'one vote – one voter' principle is ostensibly guaranteed.

This approach caused perplexity amongst the audience of the report presented by Madise at the Worldwide Forum on *e*-Democracy in Paris in 2001 and even in 2005. However, at the International Seminar held in Bregenz in 2006, Norwegian scholars remarked inter alia that they had arrived at similar principles before obtaining detailed knowledge about the Estonian Internet voting system (Skagestein et al., 2006) and expressed clear support for the vote replacement aspect of this idea. Whether one agrees with this principle or not, it is surely worth considering in some depth.

Some months before the municipal elections in 2005, the President of Estonia brought I-voting provisions to the Supreme Court for constitutional review, arguing that the possibility to change I-votes gives advantages to I-voters in comparison to non-I-voters. I-voters can change their vote for an unlimited number of times but only during I-voting and advance poll days. The initial version of the I-voting law contained the possibility to change the I-vote with a paper-ballot on the actual voting day. This provision was left out of the law, because this could have given real advantage to I-voters: they would have had the chance to change their election preference on Sunday after receiving additional information about candidates in the second half of the week. After this change, all voters who use advance poll possibilities were formally in the same conditions.

The Supreme Court Chamber of Constitutional Review pointed out that despite the repeated electronic voting, there was no possibility of the voter affecting the voting results to a greater degree than those voters who used other voting methods. From the point of view of the voting results, this vote was in no way more influential than the votes given by paper ballot. According to the Estonian Election law, each voter shall have one vote.

The court said that this interpretation renders the principle of uniform elections a special case of the general right to equality. In the legal sense, I-voting is equally accessible to all voters. The ID card necessary for I-voting is mandatory for all inhabitants of Estonia; thus, the state has created no legal obstacles for anyone to I-vote, including to changing one's vote during the advance poll days. It is a fact, that due to factual inequality, the possibility to change one's vote through I-voting is not accessible to all voters can be regarded as an infringement of the general right to equality and the principle of uniformity. The principle of equal treatment in the context of electing representative bodies does not mean that absolutely equal possibilities for performing the voting act in equal manner should be guaranteed to all persons entitled to vote. In fact, those who use different voting methods provided by law are in different situations. The guarantee of absolute actual equality of persons upon exercising the right to vote is infeasible in principle and not required by the Constitution. The aim to increase voter turnout is without any doubt legitimate. The measures the state takes for ensuring the possibility to vote for as many voters as possible are justified and advisable. Another aim of allowing I-voting is the modernization of voting practices that coincides with the aims of I-voting listed in the Recommendation Rec (2004) 'Legal, operational and technical standards for I-voting' of the Council of Europe.

In accordance with the Penal Code, preventing a person to freely exercise his or her right to elect or be elected at an election or to vote at a referendum, if such prevention involves violence, deceit or threat or takes advantage of a service, economic or other dependent relationship of the person with the offender is punishable by a pecuniary punishment or up to 1 year of imprisonment. The voter's possibility to change the vote given by electronic means, during the advance polling days, constitutes an essential supplementary guarantee to the observance of the principle of free elections and secret voting upon voting by electronic means.

A voter who has been illegally influenced or watched in the course of electronic voting can restore his or her freedom of election and the secrecy of voting by voting again either electronically or by a ballot paper, after having been freed from the influences. In addition to the possibility of subsequently rectifying the vote given under influence, the possibility of voting again serves an important preventive function. When the law guarantees a voter, voting electronically, the possibility to change the vote given by electronic means, the motivation to influence him or her illegally decreases. There are no other equally effective measures, beside the possibility to change the vote given by electronic means, to guarantee the freedom of election and secrecy of voting upon electronic voting in an uncontrolled medium. The infringement of the right to equality and of uniformity, which the possibility of I-voters to change their votes for an unlimited number of times can be regarded as amounting to, is not sufficiently intensive to overweigh the aim of increasing the participation in elections and introducing new technological solutions.

According to the opinion of the Supreme Court of Estonia, the principle of freedom of vote gives rise to the obligation of the state to protect voters from persons attempting to influence their choice. With regard to that principle, the state has to create the necessary prerequisites to carry out free polling and to protect voters from undesired pressure while making a voting decision. In paragraph 30 of the aforementioned judgement, the Supreme Court maintains the following:

> The voter's possibility to change the vote given by electronic means, during advance polls, constitutes an essential supplementary guarantee to the observance of the principle of free elections and secret voting upon voting by electronic means. A voter who has been illegally influenced or watched in the course of electronic voting can restore his or her freedom of election and the secrecy of voting by voting again either electronically or by a ballot paper, after having been freed from the influences. In addition to the possibility of subsequently rectifying the vote given under influence, the possibility of voting again serves an important preventive function. When the law guarantees a voter, voting electronically, the possibility to change the vote given by electronic means, the motivation to influence him or her illegally decreases. There are no other equally effective measures, besides the possibility of changing the vote given by electronic means, to guarantee the freedom of election and secrecy of

> voting upon electronic voting in an uncontrolled medium. The penal law sanctions have a preventive meaning but subsequent punishment – differently from the possibility of changing one's electronic vote – does not help to eliminate a violation of the freedom of election and secrecy of voting (Chamber of Constitutional Review of the Estonian Supreme Court, Decision Nr 3-4-1-13-05).

The Supreme Court thus confirmed the constitutionality of one of the main premises of the remote Internet voting project. While Drechsler and Annus claimed (quite reasonably for the period 1992–2001) that in its interpretation of the Constitution, the Supreme Court of Estonia avoids the teleological and systematic interpretation method along with the social science viewpoint (Drechsler and Annus, 2002), the case of remote Internet voting is one evidence of a shift. It is true that the tradition of belonging to the German legal space and the influence of Kelsen's ideas in *Reine Rechtslehre* on Estonian jurisprudence (Mälksoo, 2004) have reinforced the emphasis on pure discussion of norms rather than a focus on social reality. Yet, at least the ideas of public law reforms have already moved away from the technical positivist *Subsumtion* method. Already in 2001, Narits treated the discussion over the objective of the meaning and norm of law as a clear tendency in the late practice of the Supreme Court (Narits, 2001).

17.5 Technical Solution

17.5.1 ID Card as a Tool for Secure Interaction in Internet

Over the last decade, governments across the world are increasingly using the potential of ICT to increase the efficiency of their services. This, in turn, has brought new challenges. Some of the biggest in the sphere of *e*-Government are the identification and authentication of a citizen. Simple password-based authentication methods are not secure enough. Estonia chose the electronic ID card as main authentication tool. Although many states across the world already have some form of identity card schemes in place, few are based on electronic cards. However, in Estonia ID card, enabling secure personal authentication and digital signing, as well as the Public Key Infrastructure (PKI) necessary for using ID cards electronically, had been developed already by the end of 2001.

Issued by the Estonian Government since January 2002, national ID cards represent the primary source of personal identification for people living within Estonia and are mandatory for all citizens and resident aliens above 15. The ID card carries two functions: physical identity as a regular ID and electronic identity which enables citizens to use the same card to electronically authenticate to websites and networks, and/or digitally sign communications and transactions as required.

Each card contains two discreet PKI-based digital certificates – one for authentication and one for digital signing. The certificates contain only the holder's name and personal code and have two associated private keys on the card, each protected by a unique user PIN. The certificates contain no restrictions of use: they are by nature universal and meant to be used in any form of communications, whether between private persons, organizations or within the government. As mentioned before, the card can be also used for encryption of documents so that only the person intended to view the document can decrypt it. This is an efficient means for secure transfer of documents using public networks. In addition to that, each ID card contains all data printed on it also in electronic form, in a special publicly readable data file.

The Estonian government, as well as private companies in the country, are increasingly deploying secure infrastructure over the Internet and migrating its' services (Internet banking, tax declarations, voting, ticketing etc) to the virtual world, removing physical barriers to services and reducing transaction times (Martens and Maaten, 2006).

17.5.2 Measures Used to Ensure Voting Secrecy

One of the main interests of those interested in the security of Internet voting systems is the obvious contradiction of security and secrecy properties. On one hand, voting must be private and votes remain anonymous. On the other, voters must be identified in order to guarantee that only the eligible voters are able to vote and that they vote only once.

In order to understand how the I-voting system guarantees the secrecy and singularity of vote, we should describe shortly the envelope voting method used in Estonia for advance paper voting. The latter gives the voter possibility to vote outside the polling station of the voter's residence in any rural municipality or city. A voter presents a document to be entered in the list of voters, and then receives the ballot and two envelopes. The inner envelope has no information about the identity of the voter and the ballot paper is put in it. The inner envelope is put into an outer envelope and the voter's details are written on it, so that, after the end of the advance poll, the envelope could be delivered to the voter's polling station of residence. There it is verified whether the voter has the right to vote; then, the inner envelope is taken out and put unopened into the ballot box. The two-envelope system guarantees that the voter's choice remains secret. Additionally, recording the data about envelope I-voting in the list of voters in the polling station of residence prevents voting more than once (Fig. 17.1).

Upon voting by electronic means a voter makes her or his choice, which is encoded (placed in a virtual inner envelope). Thereafter the voter shall approve the choice through his or her digital signature, which means that personal data is added to the encoded vote (the outer envelope). The personal data and the encoded vote are stored together until the counting of votes on Election Day, with the aim of ascertaining that the person has given only one vote.

The personal data of a voter and the vote given by the voter are separated after the fact that the voter has given only one vote has been checked and repeated votes have been eliminated. It is then possible to open the inner envelope only after the personal data added to the encoded vote have been separated.

I-voting, like voting outside the polling station of residence, is possible only during advance polls. This is necessary to guarantee that, in the end, only one vote

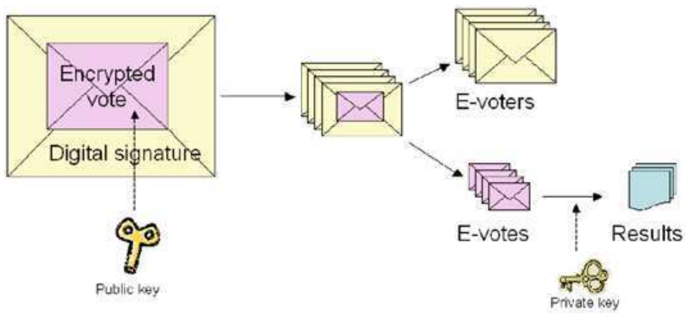


Fig. 17.1 Double-virtual-envelope method for I-voting

is counted for each voter. During the I-voting process, the voter's right to vote is checked, but if the voter uses the possibility to cancel his or her vote by going to vote at the polling station during the advance poll, then it has to be guaranteed that finally only one vote is counted for each voter. For that, all polling stations are informed of the I-voters on their list of voters after the end of advance polling and before the Election Day on Sunday. If it is found at the polling station that the voter has voted both electronically and with paper ballot, the information is sent to the NEC who cancels that voter's I-vote. Before the verification of voting results in the evening of the Election Day, the encrypted votes and the digital signatures with personal data or inner and outer envelopes are separated. Then all I-votes are opened by the NEC and counted. The system opens the votes only if they are not connected to any personal data.

17.5.3 System Architecture

The Estonian IT security experts in their security analysis[1] published in 2003, declared that in *practical sense* the Estonian I-voting system was secure enough for implementation. In absolutely secure systems, unexpected events are not possible. One may dream about such systems, but they can never be achieved in practice. This applies particularly to I-voting systems. Considering the security level of personal computers, it is impossible to design I-voting systems, which are absolutely secure for every user. The most important security goal of voting is not to affect the final results and not to abuse the principles of democracy. The single incidents with users are still important, but they do not have influence to the final result. Moreover, even in traditional voting systems small-scale incidents are acceptable (Mägi, 2007).

I-voting part in the whole process of organizing elections is relatively small. The system uses existing information systems – Population Register as polling list,

[1] http://www.vvk.ee/public/dok/e-voting_security.pdf

election information system of the NEC for the collection and publication of information on candidates and voting results and the infrastructure of Certification Centre Ltd for checking ID card certificates.

The main components of the Estonian I-voting systems are as follows: the Voter Application; the Vote Forwarding Server; and the Back-office, which is divided in two, the Votes Storing Server and the Votes Counting Server. These components support the following processes:

The *voter application* is a web application or an application in voters' personal computers to cast votes.

The processes of *Vote Forwarding Server* are authentication, the checking of franchise, sending a candidates' list to voters, and receiving signed and encrypted ballots. The network server immediately transfers the received encrypted ballots to the Votes Storing Server and transposes the acknowledgements of receipt from the Votes Storing Server to the voters. The Network Server completes the work when the I-voting period finishes.

The *vote Storing Server* receives encrypted ballots from Network Server and stores them until the end of the voting period. Votes Storing Server has a responsibility of votes' managing and canceling.

The *vote Counting Server* is an offline server, which summarizes all encrypted ballots. The encrypted ballots are transferred from Votes Storing Server to Votes Counting Server by using data carriers. Votes Counting Server does not get voters' digital signatures and it does not know voters' personal data.

Additionally, the I-voting system delivers independent log files, which consist of trace of the received encrypted ballots from the Vote Forwarding Server, all annulled encrypted ballots, all encrypted ballots sent to the Vote Counting Server, and all counted encrypted ballots. The cryptographic protocol used links all records in the log files. The NEC has the right to use the log files to resolve disputes. Hence, there is an independent audit trail to verify *e*-voting process and help solve problems should they appear (Fig. 17.2).

Asymmetric cryptography is used to guarantee the secrecy of votes. A pair of keys is generated for the system in a special safety module so that its private component never leaves it. The public component of the pair of keys is integrated into the voter application and is used to encrypt the votes. The private component of the pair of keys is used in the Vote Counting Application to open the votes on Election Day evening. The NEC can open the votes, i.e. use the private component, only collegially. After the end of the period of dealing with possible complaints the private key is destroyed.

17.6 Users' Perspective

The Internet voting system takes advantage of the existing infrastructure and governmental databases. To vote electronically, a voter does not need to register himself or herself additionally. The voter needs an ID-card and a computer connected to the

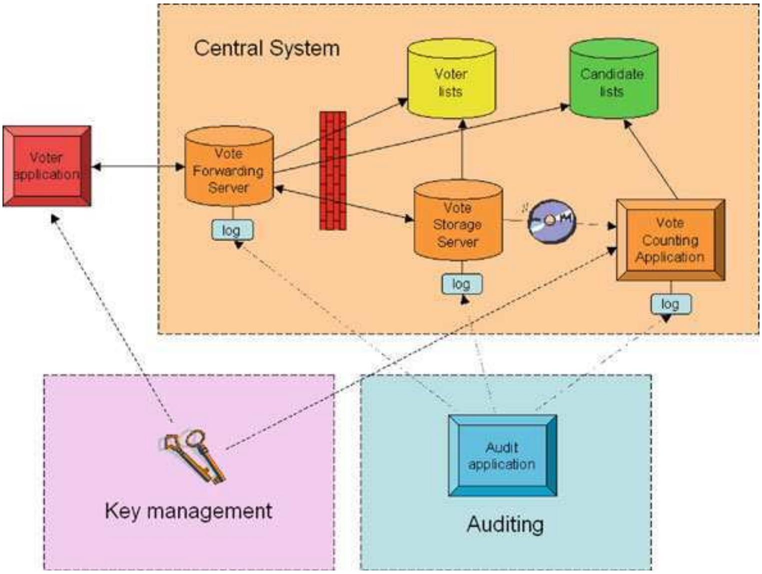
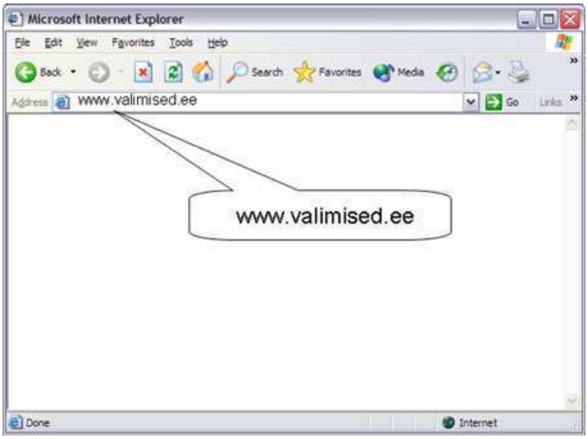


Fig. 17.2 General architecture of I-voting system

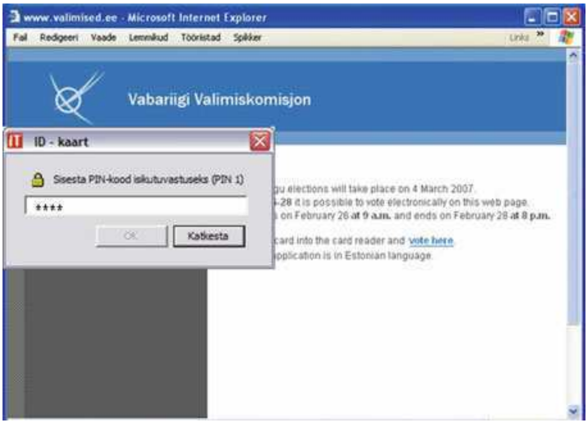
Internet and with an installed card reader. He also needs PIN-codes for identification and signing. He or she can use the same tools for other transactions, including governmental *e*-services and Internet banking.

From the user's perspective, the voting procedure looks like this:

1. A voter inserted the ID-card into the reader and opened the voting page.

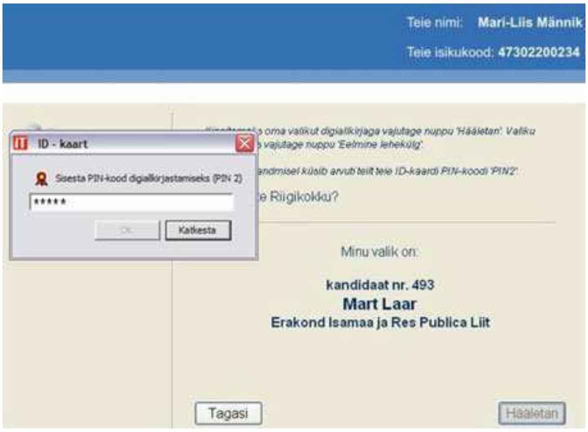


2. The voter authenticated him/herself using the PIN1 of the ID-card.



3. The server checked whether the voter was eligible (using the data from the population register).
4. The candidate list of the appropriate electoral district was displayed.

5. The voter made his/her voting decision; the system encrypted it.
6. The voter confirmed his/her choice with a digital signature by entering PIN2 of the ID-card. The system checks whether the same person who authenticated himself/herself during the start of the session gave the digital signature. Also the validity of the digital signature is confirmed by the validity confirmation server.



7. The system confirms that the vote has been stored in the Vote Storing Server.

17.7 Impact Analysis

One cannot avoid the issue of the digital divide, the question of whether Internet-based voting exacerbates the difference of representation possibility within social groups. What is clear is that Internet-based voting removes physical barriers hindering participation in elections of the aged, disabled or other groups with restricted mobility or who have difficulty in attending polling stations (e.g. persons having tight work schedules or working abroad, parents of small children and persons living in regions with poor infrastructure), assuming, of course, that these people have access to the Internet.

Trechsel et al. concluded in the report prepared for the Council of Europe following the experience of the Internet voting in 2005 and 2007 that education and income, as well as type of settlement are insignificant factors while choosing the Internet from other voting channels. One of the most important findings of that study was that it is not so much the cleavage between the Internet access haves and access have-nots, but clearly computing skills, frequency of the Internet use and trust in the I-voting procedure that direct voters' decisions to use or not I-voting. Age remains a significant factor for some years.

The actual impact of Internet voting on the change of turnout does not lend itself to objective analysis. One can determine the variations of turnout in different election years (comparing equivalent types of elections) and attempt to clarify the causes underpinning variations with the help of sociological studies. Perhaps the most important question is what share of the electorate would not have participated in the voting, had the Internet voting opportunity not been provided. There exists no way of obtaining empirical evidence. We must, therefore, come to terms with unverifiable claims made by the voters themselves. The only exception is the case

Table 17.1 I-voting statistics of 2005, 2007 and 2009 elections

	2005 LE	2007 PE	2009 EPE	2009 LE
I-votes	9,681	31,064	59,579	106,786
Repeated I-votes	364	789	910	2,373
I-voters	9,317	30,275	58,669	104,413
I-votes cancelled by paper ballot	30	32	55	100
I-votes counted	9,287	30,243	58,614	104,313
Valid votes casted	496,336	550,213	396,982	658,213
% I-votes	1.9%	5.5%	14.8%	15.7%
% I-votes among advance votes	7.2%	17.6%	45.4%	44.1%
I-votes cast abroad (51 countries in 2007, 66 in EPE, 88 LE in 2009)	n.a	2%	3%	3%

when Internet voting is the only possibility for the elector to vote and he or she uses this possibility. For example, the local government council elections in Estonia do not provide for voting abroad by postal ballot or at a diplomatic representation. Nonetheless, they do envisage the possibility of voting on the Internet. We briefly analyse here some of the results concerning I-voting in Estomia for the 2005 and 2007 elections. We also provide the 2009 results, although we do not comment on them in this chapter (Table 17.1).

In 2005, the I-voting seems to have had a slight effect on the increase in the turnout of the voters who sometimes vote and sometimes not (Breuer and Trechsel, 2006). In 2007, approximately 10% of the questioned I-voters said that they certainly or probably would not have voted without having had the possibility to vote via the Internet. The most intriguing question for political parties is probably the impact of the use of I-voting on results. Although parties favouring I-voting have gathered in 2005, as well as in 2007, most of the I-votes (Madise, 2008; Madise et al., 2006), the study shows that left-right auto-positioning does not play any important role while choosing a voting channel (Trechsel, 2007).

Approximately one-fifth of the questioned non-I-voters pointed out that a reason for not I-voting was the sufficiency of the paper-ballot system. Lack of trust with 3.2% and absurdity of I-voting with 1.9% were not dominant reasons. Prior to the actual I-voting there was a concern that the possibility to change the I-vote is going to be misused. It was not the case. The general statistics shows that the number of amended I-votes was insignificant. As was noted previously, the improper influence of remote voters by others is a theoretical but potentially significant problem, although such threats are tolerated with vote-by-mail in numerous jurisdictions. If we consider the experience of voters in the two I-voting experiences, we see that there is little evidence of coercion or concerns about privacy, based on voters' behaviour. The small percentages of repeated votes as well as the significant increase on the total number of I-voters from 2005 to 2007 indicate that the confidence in the existing I-voting system has grown.

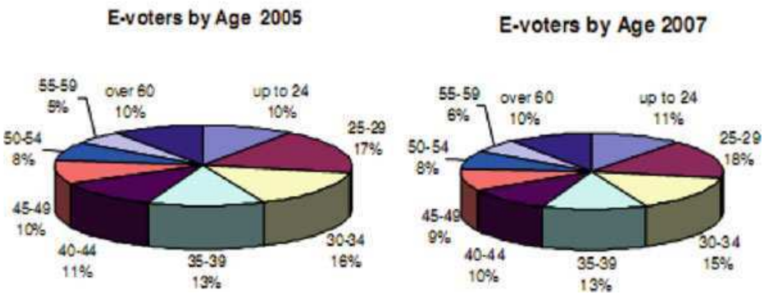


Fig. 17.3 Age of I-voters in 2005 and 2007

The hypothesis that I-voting rewards advantages to urban electorate found no proof. Gender is not an important factor when choosing I-voting from possible voting channels. Age, on the contrary, is quite an important factor: most I-voters in both elections belong to the age group 18–39 (Fig. 17.3).

However, the legitimacy of Internet voting cannot be judged solely on the basis of its impact on political alienation. The legitimacy and constitutionality of Internet voting as well as its impact on democracy are only briefly discussed. It is too early to make strong statements on that topic – on one hand, the remote Internet voting experience has too thin a basis for that, on the other, the socio-political environment is steadily changing.

17.8 Challenges

17.8.1 Transparent Election Administration

How to create trust and guarantee the transparency of electronic voting? Internet voting represents new opportunities for improving the electoral process but it also presents new challenges.

Simple methods have been used in Estonia to increase voter understanding and confidence in the I-voting system in an attempt to overcome any concerns about the lack of transparency and complexity. In both elections in which I-voting was used, prior to the voting period the government allowed all individuals eligible to vote the opportunity to test out the I-voting system in order to encourage people to see how the system worked. This helped the voters detect any problems they might encounter before the real I-voting period started. In Estonia, the primary concerns among the country's election officials, outside observers, political parties, and citizens, relate to the cost and acquisition of the hardware and software needed to read an ID card on a personal computer, updating expired ID card certificates, and the renewal of PIN codes needed for electronic use of the ID card. The government engaged in a nationwide pre-election information campaign to inform voters about these potential issues and encourage voters to try the system before the voting period started. In the 2007 elections, about 4,000 voters did test the system.

Voters were also informed that, once the live voting period had started for I-voting, they should verify the authenticity of the voting application. Before the I-voting period started, the election officials published information about the cryptographic hash functions that were used and during voting period voters could examine the checksums. As an additional element of transparency, the number of I-voters who had cast ballots was updated regularly on the I-voting website during the early voting period. This very simple process allowed the wider national audience, as well as the political parties, know how many I-voters had voted and determine if the trend in the number of I-voters casting ballots seemed reasonable. In the end, people were also able to compare the number of I-voters with the number of I-votes counted.

In order to convince voters that their votes had been correctly registered, voters had an option to check whether their valid I-vote had been reflected on the polling lists on election day in order the prevent voting more than once. A second option for verifying the correctness of a valid I-vote was possible during I-voting period. If the voter decided to replace the I-vote with a new one, he got a notification of an earlier recorded I-vote.

17.8.2 Observation in Practice

According to the Estonian electoral laws, all activities related to elections are public. Observers have access to the meetings of all election committees and can follow all electoral activities, including the voting process, counting and tabulation of results. Internet voting has been no different. All significant documents describing the I-voting system were made available for all, including observers. In order to enhance the observers' knowledge about the system, political parties were invited to take part in a training course before each election in which I-voting was used. Besides political parties, auditors and other persons interested in the I-voting system also took part in the training, which was followed by surveys of concrete procedures that were necessary for a set up of the I-voting system. Observers were invited also to a test of the counting process. However, few political parties exercised their opportunity to observe the I-voting procedures.

Throughout the I-voting observation period of 1 month, the main observation tool was the checking of activities of electoral administrators against written documentation describing the necessary procedures. The key management function required extra attention, as the security and anonymity of I-votes was predicated on the encryption and decryption of votes. During the counting event – the highlight of the election period – the management of the systems' private key, which is the warranty of the electoral secrecy, was demonstrated to observers. This key was mastered by the NEC and its members opened collegially the anonymous encrypted votes. The process of counting of ballots was conducted with observers able to watch all ballot counting activities on large screens in the observation area. The process was fully narrated and observers were able to follow each step.

It is important that observers are deployed for a length of time necessary to allow meaningful observation. If some important stages influencing the correctness of final results have not been observed, the conclusions about the integrity of the system cannot be made. I-voting procedures start several weeks before the elections day. Especially for casual foreign observers, the length of the observation period has appeared to be a challenge. The OSCE did audit the 2007 elections and in its report it states “election administration implemented the [Internet voting] system in a fully transparent manner, and appeared to take measures to safeguard the conduct of Internet voting to the extent possible” (OSCE, 2007).

17.8.3 Validating the Voting Systems

In order to validate the electronic voting system, certification procedures should be established and other measures like testing and audits of different aspects should be considered. Currently there is no domestic or international body that is ready to certify the Estonian I-voting system. Estonia instead uses a system similar to that used in other countries, where a third-party audits the source code and the operational procedures have been carried out. System testing was also done in order to control the functionality and accuracy by contracted testers and by public.

The Estonian I-voting system was developed with the underlying principle being that all components of the system should be transparent for audit purposes. Procedures should be fully documented and critical procedures should be logged, audited, observed, and videotaped as they are conducted.

Specifically, during the last elections, the NEC has conducted audits on the source code and the electoral procedures. A common requirement is that the source code of the voting system should be available for auditing. In Estonia, though, the code was not universally available but it could be audited if agreed to by the NEC. As a rule audit by an external internationally certified IT auditors is ordered. The audit reviewed and monitored security sensitive aspects of the process continuously, such as updating the voters list, preparation of hardware and its installation, loading of election data, maintenance and renewal of election data and the process of counting the votes. On the counting event on the Election Day, auditors publicly declared their opinion about the correctness of the procedures of the electoral administration so far. The report of auditors, released after all procedures, including the deletion of I-votes, were over, stated that the I-voting followed the rules described in the system’s documentation and the integrity and confidentiality of the system were not endangered.

The OSCE, in its report about the 2007 Parliamentary elections, recommended that, in addition to the audits of the process now conducted, all components of the system should be audited by an independent body in accordance with publicly available specifications, with all reports made public (OSCE, 2007). The NEC has not published the audit reports referring to the contracts and given the consideration that publishing reports could make the system more vulnerable to attacks. In the future, the NEC should consider asking its auditors to produce both an internal audit report, intended for the NEC, and a report that can be made public, with certain information redacted.

The I-voting system produced a wealth of system log information that can be used to monitor the work of the system thoroughly. In its different production functions, the I-voting system produces different logs on received, cancelled, and counted votes, also invalid and valid votes. The Audit Application enables to determine what happened to an I-vote given by a concrete person without revealing the voter's choice. These logs provide external auditors as well as observers with information that they can use to ensure that the system is working correctly.

17.9 Conclusions

Estonia is the first country in the world where Internet voting with binding results was successfully used countrywide. The whole Estonian electorate had the possibility of casting the vote via Internet in local (2005 and 2009), parliamentary (2007) and European Parliament elections (2009). Launching I-voting constitutes a genuine qualitative change in the development of the electoral system and electoral administration. The Estonian I-voting experience proves that it is possible to guarantee the conformity of remote I-voting with all constitutional electoral principles including the principle of secrecy.

The ID card as a primary identification document in Estonia with two mandatory functions – remote authentication and digital signature – is the corner stone of the double-virtual-envelope system. Reliable identification of the voter as well the vote's anonymity and correct counting of the votes thus secured.

An important factor explaining the possibility to launch totally new solutions like I-voting in Estonia is the smallness of the country. Lennart Meri, the late president of the Republic of Estonia compared in his speech at St. Olaf College in Minnesota on April 6th 2000 Estonia with a small boat: "A super tanker needs sixteen nautical miles to change her course. Estonia, on the contrary, is like an Eskimo kayak, able to change her course on the spot."

As long as universal and secure Internet access is not guaranteed, the doubts related to the political neutrality of this technique will probably remain. Nevertheless, I-voting should be regarded as an essential public service in an information society. Problems with voting machines as faced in the Netherlands and recently in Finland, should not be widened to remote Internet voting, although it does not mean that I-voting does not embrace any risks and will never face any challenges.

The basic question in electoral administration no longer focuses on whether new technology developments are acceptable in electoral processes but rather on what kind of technology is suitable for a specific country, taking into account its political and social culture, level of technological infrastructure, and its electoral system. In the Estonian case, the preconditions were favourable for introducing the most ambitious change in the nature of voting – voting over Internet.

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Chapter 18
Consensus Building by Blended Participation in a Local Planning Process: The Case of the Public Stadium Swimming Pool in Bremen

Herbert Kubicek and Hilmar Westholm

18.1 Theoretical Background and Practical Approach

There are high expectations that electronic ways of citizen participation in public planning and decision making may increase the quality and legitimacy of the decision and may help to overcome some of the democratic deficits indicated by low voter turnout, decreasing engagement in political parties, distrust in political bodies and politicians among others. However, experience from the early days of tele-democracy to recent large-scale web-based consultation processes shows that technical instruments have not been able so far to bring about such cultural changes but can only support or enforce change brought about by institutional reforms.

Therefore, any discussion or assessment of technical participation instruments (*e*-tools) has to consider the social context in which they are to be implemented. The instruments or tools are part of a participation procedure which itself is embedded in an institutional context including legal regulations, organizational provisions, norms and values of different stakeholders and many more (Fig. 18.1). The technical tools and other elements of the participation process should fit or match these conditions, as they are the prerequisites for those addressed by the participation process to accept the invitation, engage in the process, make use of the instruments, and, finally, accept the outcome and result of the whole process.

For a long time to come, there will be no public participation, which is offered by electronic means only. *E*-tools do not and will not completely substitute traditional means, such as physical meetings or written questionnaires, but rather complement them to different degrees according to the target groups and subject of the participation in a multi-channel or multimedia approach (see Kubicek et al., 2009). This was described as blended participation in **Ríos Insua and French**.

Adopting a resource-oriented approach, participation for citizens is not only a right provided by law, e.g. in urban planning but also an activity, which affords investing their time and devoting their attention, and thus is in competition with

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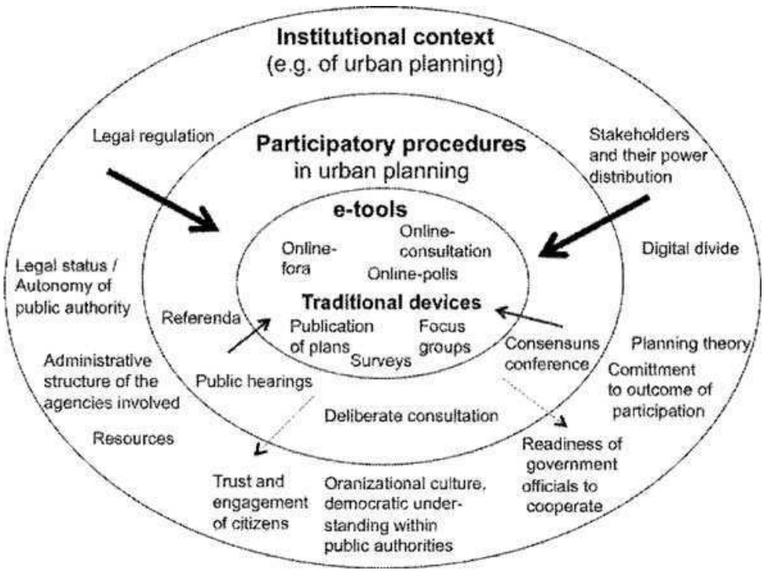

Fig. 18.1 Participation context within urban planning

other forms of engagement offering greater gratification. Therefore, the invitation to participate must meet a certain level of concernment by the issue at stake and the expectation that participating will make a difference. This expectation in turn depends on the kind of participation which is offered. Very often political bodies or government agencies speak of participation if they only provide information open for comment. In other cases, they conduct a formal consultation on one specific and elaborated plan.

Back in 1971, Arnstein proposed a ladder of participation with eight levels of increasing citizen power starting from “non-participation” (“manipulation” and “therapy”) to “tokenism” (“informing”, “consultation” and “placation”) to “degrees of citizen power”, i.e. “partnership”, “delegated power”, and “citizen control”. A similar distinction was proposed by Wiedemann and Femers (1993), starting from the “public’s right to know” and leading over the “right to object” and “participation in recommending solutions” to “participation in the final decision”. There is not only academic consent that “real participation” requires real influence. Also political declarations, e.g. a recommendation by the Council of Europe on the participation of citizens in local life (Rec. 2001/19), demand to “give citizens more influence over local planning and budgetary and financial planning” in order “. . .to ensure that direct participation has a real impact on the decision-making process, that citizens are well informed about the impact of their participation and that they see tangible results. Participation that is purely symbolic or used simply to grant legitimacy to pre-ordained decisions is unlikely to win public support. However, local authorities must be honest with the public about the limitations of the forms of direct participation on offer, and avoid arousing exaggerated expectations about the possibility of accommodating the various interests involved, particularly when decisions are made between conflicting interests or about rationing resources" (Council of Ministers, 2001, Section C 5).

The Council recommends that "deliberative consultation" should be enhanced in order to make it become true participation through other provisions:

> 3. Make full use, in particular, of . . . more deliberative forms of decision-making, i.e. involving the exchange of information and opinions, for example: public meetings of citizens; citizens' juries and various types of forums, groups, public committees whose function is to advise or make proposals; round tables, opinion polls, user surveys etc. (Council of Ministers, ibid.)

However, so far these recommendations are seldom followed. Too frequently, elected politicians fear that giving more influence to citizens might start a self-enforcing process undermining representative democracy. According to empirical studies, they prefer to look at citizens as customers and conceive participation as a matter of customer relations management (e.g. Creasy et al., 2007; Pratchett et al., 2005). However, there are a few cases in which the highest level of the Arnstein ladder has been reached, and participation in the final decision-making has been offered. Such a process took place in the Free Hanseatic City of Bremen, Germany, when it was felt that its largest public swimming pool, the Stadionbad, needed renewal.

We were involved in this process in a form of action research providing electronic instruments to the participation process, supporting communication strategies and conducting an evaluation. The context was a research project dealing with "The Media Mix in Local Democracy" funded by the German Hans Boeckler Stiftung (Kubicek et al., 2009).

That project conceived participation as a set of communication processes on two related levels. At a primary level, participation instruments or tools, such as town hall meetings or online forums, are communication services or opportunities designed by an agency addressing certain target groups, which make use of these services to different degrees. This may be explained by concepts of communication and media research such as the uses and gratification approach, according to which people use media to the extent they expect and/or gain certain gratifications, which satisfy any kind of need. A specific focus of our research, however, lies at a second level which we call meta-communication and deals with information and communication strategies and instruments which draw attention to the primary communication and/or explain the rules of this first-order process.

The participation process around the Stadionbad can be considered as a decision-making and negotiation process in which different groups of stakeholders brought in their preferences for the future shape of the public swimming pool and the official bodies adopted the results of this negotiation. The crucial condition to actually link the consultation and the final decision was the representativeness and fairness of the designed process.

In the context of this volume, our case study supplements the cases of formal group decision-making models. Decisions were taken in face-to-face meetings based on information, partly generated by online tools but mostly face-to-face. Therefore, it is a case of blended *e*-participation or hybrid participation. The process itself and the case analysis, however, offers the opportunity to recognize and understand the socio-cultural context in which such formal techniques have to be embedded, and it points to supportive non-technical measures which seem to be necessary in order to achieve acceptance of such instruments.

18.2 Project Context and Main Stakeholders

The city of Bremen with 550,000 inhabitants together with its harbour, the city of Bremerhaven (110,000 inhabitants), is the smallest Federal State in Germany. The Stadionbad is the central outdoor public swimming pool of the city. It is located adjacent to the city's football stadium, with about 75–115,000 visitors per year. For some time, operating costs were high, and the building complex on the swimming pool grounds needed renovation. A redevelopment was inevitable. But there was a controversy between the political parties about whether this should be done in a traditional way or in a more ecological direction on a chlorine-free basis. When a new city and state parliament was elected in 2001, the city district council took the initiative to organize a broad consensus-oriented citizen participation process. The renovation project was successfully included in the coalition agreement between the two ruling parties acting as the new city and state administration. The Bremen Senate, the City and State Government, provided 2.5 million Euros to the renovation, and a contract was concluded between the state and city governments and the city district to involve the public implementing the results of this participation project. However, constitutional responsibilities and decision-making authority were not overruled: a parliamentary committee still had to decide on the funding in the end. But the parties involved committed themselves to organize a consensus-oriented procedure, and if a consensus was reached, it should have a great impact on the final decision.

Figure 18.2 shows the complex decision-making structure within the city and district governments: the Bath company running the swimming pool had to submit a formal proposal for a renewal to the Senator of the Interior and Sports, the responsible government branch. He had to submit the proposal and a budget request to the Sports Deputation, a joint body formed by the city and state governments and members of the sports committee of the city and state parliament. The Sports Deputation would then approve the proposal and mandate the Senate, the City Government, to include this project in the next annual budget, which has to be approved by the State Parliament. After budget approval within the City and State Governments, the Senator of Construction, Transport and Environment responsible for public construction takes over and opens the tendering process for construction plans.

At this point, the participatory approach changed the traditional decision-making structure and processes:

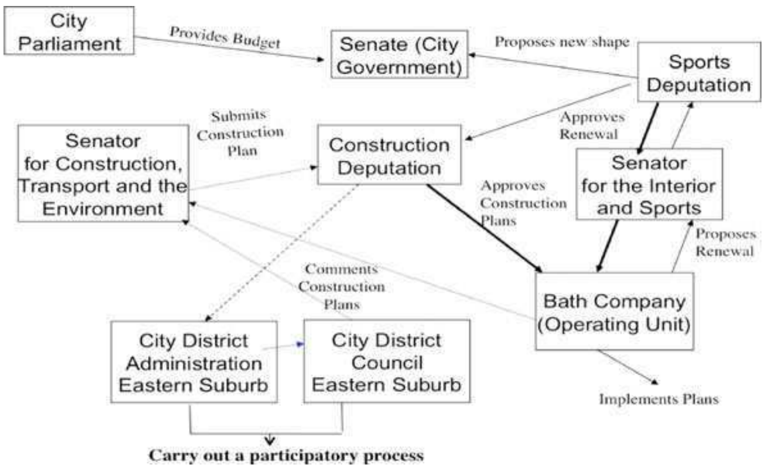

Fig. 18.2 Actors involved in the decision-making process

The City and State Government gave the Council of the City District "Eastern Suburb", where the swimming pool is located, a greater say in the choice of the design and agreed to conduct a public consultation. This new procedure was laid down in a formal written agreement between the Senator of the Interior and Sports, the Sports Deputation, the City District Council and the City District Government. In this agreement on citizen participation in the renewal of the Stadionbad (February 5th, 2004), the signatories agreed that the district would submit a recommendation for the type of renewal, based on a broad citizen participation, and that the Deputation and the Senator will adopt this recommendation, should it meet the requirements laid down in the agreement and if the participation process is fair, neutral, consensus- and result-oriented.

The requirements defined in the agreement included the capacity of the pool (4,000 visitors per day), the quality of the water defined through technical standards, the pool shall blend into the environment (riverside), be appropriate for sports and competitions, and the construction costs should not exceed 2.5 million Euros.

The agreement also included the procedural requirement that the private planning office, which would work out the technical specification and the formal plans, had to take into account that they would be dealing with a complex participatory process involving active and potential users of the pool, in particular children and youth, athlete swimmers and citizens in the neighbourhood. Therefore, the plans were first to be restricted to basic technical aspects leaving much discretion for the participatory design.

Accordingly, two planning offices were involved, one preparing a basic plan of a traditional public swimming pool and a second one preparing a plan for an ecological public swimming pool, both as input for the participatory process. The District Council, besides the traditional decision-making bodies, identified the following stakeholders:

- Representatives of sports clubs,
- students and teachers from schools in the district,
- children and youth,
- families with small children,
- elderly people,
- leisure users,
- organizations in the neighbourhood.

The City District Council set up a small management team consisting of the City District Manager, the civil servant in charge of work with the youth and an external facilitator hired to coordinate the process. In addition, they established a committee called the "Patenkreis" which consisted of 25 persons representing the different decision-making bodies and other stakeholders such as swimming clubs, schools, etc. This group met physically every 3–4 weeks in non-public meetings. It was something between an advisory board and a steering committee. It was the seismograph for all developments in the process; they identified problems, prepared and finished other sub-processes, thought about which target groups could be reached by which measures, identified the issues not yet dealt with, collected ideas from other participation methods and presented the results to political bodies. As families with small children, elderly people and leisure users do not have an organized representation at the local level, they were not represented in this committee, but other ways of identifying and including their interests and preferences had to be found and employed.

The external facilitator had to moderate the meetings of the Patenkreis as well as the whole process; and the research institute of the authors was involved for consulting on employing electronic tools as well as evaluating the participation process.

18.3 The Decision-Making Process

Following the three-phase model of Formulate, Analyse and Decide, in this section we will describe the general approach and particular role of *e*-tools in each phase.

18.3.1 The Formulation Phase

With the help of a professional moderator, the Patenkreis defined its objective as reaching a "district vote" on the final design of the swimming pool. Members did not see themselves as fighting for particular interests but rather as identifying the whole range of requirements and finding a consensus solution. This had to be very open in the beginning and identify and include as many views as possible. For this purpose, a 1-day starting workshop was organized, moderated by another external facilitator. More than a hundred organizations or individuals were identified as stakeholders by the Patenkreis and invited to participate in this workshop. Sixty five persons attended.

As mentioned, the planning offices were affiliated to two different approaches of the new swimming pool: the City district council preferred an ecological concept and hired a specific planning company to prove this concept, whereas the Bath company preferred a traditional basin with chlorinated water and hired a planning company experienced with these kind of swimming pools. Each concept was presented in a 15-min powerpoint presentation to illustrate the different approaches and their financial and practical consequences. After a short plenary discussion, the 65 participants were assigned to five groups reflecting the interests of different users of the swimming pool: the elderly, athletic swimmers, youth, families with small children and senior bathers.

Each group used a flip chart with three questions on it:

- Imagine that the new concept would optimally provide for the interest of your group. How would the group know?
- What do you think: with which group will it be most difficult for your group to find a common solution?
- What could your group do to find a solution that everyone concerned could live with?

First, each group went to the paperboards of the other groups and wrote answers on small cards. Finally, they went to their own boards, looked what the others had put there and added their own answers. Based on the answers to the second question, the moderator formed three new groups where members of groups with opposite interests worked out recommendations and questions to the planners.

This method developed by the moderator Guus van der Upwich turned out to be very effective to create understanding among the different interest groups in a controversial design process. A very important effect was that everybody was forced to appreciate the needs of other groups. Thus, the basic understanding that a solution would only be possible if the interests of the other swimming pool users were considered was created, which is a practical illustration of what (Coleman and Goetze, 2001, p. 6) define as deliberative participation.

“Methods of public engagement can be described as deliberative when they encourage citizens to scrutinize, discuss and weigh up competing values and policy options. Such methods encourage preference formation rather than simply preference assertion.”

Deliberative consultation therefore is the alternative to formal public hearings, which according to Innes and Booher (2004) does not lead to consensus because the setting of this form of consultation leads participants to shorten and sharpen their arguments. The authors, in their role as consultants on the employment of *e*-tools, did not propose starting with an online forum instead or besides this 1-day workshop. The complex exchange of arguments would hardly have taken place in an online communication. But even if this would have been possible, online communication cannot create the climate and feeling of mutual understanding, which emerged when the groups were visiting each other’s paperboards.

As the starting workshop could not cover all stakeholders, the steering committee initiated several additional measures in order to include as many views and ideas as possible (see Fig. 18.2). The basic approach was not only to invite people to come to meetings but rather to meet them where they regularly were, if possible.

In order to find out the preferences of children and youth, an advocate planner from the City's youth department went to a day-care group and an elementary school and made the children draft models of their ideal swimming pools under the guidance of a so- called adventure pedagogue, a social worker with particular skills to motivate and guide children in exciting leisure activities The ideas and models were presented by the children, parents and educators (or by the children to the parents and educators) and later on introduced into the next phase of the process by the advocate.

Older pupils in the classes 9 and 11 were visited in their classrooms and asked to produce "hit-and-shit" lists compiling what they would like to see in the new swimming pool and what they disliked. The lists of the classes were integrated in and presented on a "Future Festivity", a party at the pool with almost 100 participants. A summary was produced by the civil servant in charge for youth work supported by some pupils who were members of the Patenkreis. The summary was introduced into the next phase.

For other stakeholders, further events were organized to generate ideas for the new bath (Fig. 18.3):

- Two excursions were offered – one on the site of the existing pool to visualize the different plans and their consequences onsite (e.g. heights differing from the existing outfit, the dimensions of the pools compared to the existing pools; see Fig. 18.4). A second excursion led the participants to ecological swimming pools in other cities.
- A public hearing was organized to create a productive controversy between the protagonists of the chlorination of the water and those of the biological cleaning

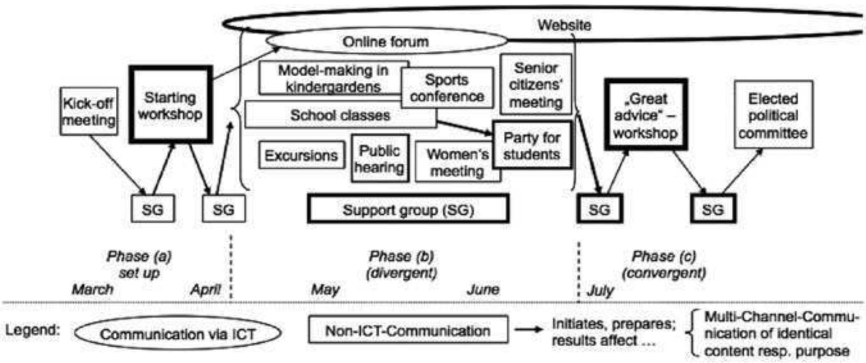

Fig. 18.3 Sequence of events to include different stakeholders

Fig. 18.4 On-site planning exercise

of water to explain and discuss the arguments about hygienic, ecological, and health aspects.

- The discussion led, for instance, to the result that women and girls had other priorities than boys and men (e.g. the women wished measurements against rubbernecking men such as hedges, and they were more interested in clean changing cubicles and preferred soft ball games instead of hard ball games, such as football). Therefore, a specific meeting for women and representatives of women organizations was arranged.
- Since senior citizens were identified from the Patenkreis as a specific group with distinct interests, and a senior citizen meeting was organized to gain their views. However, this meeting failed, and only two senior citizens participated.
- The athletic swimmers were represented by board members of the swimmers' sports clubs and other sports clubs. To gather feedback from the members of their organizations, a sports conference was organized. Although only a small number of athletic swimmers participated, important results were that they wanted a bath that provided the opportunity for official swimming sports competitions (e.g. 50 m-lanes), clear water, and water (at least 20°C).
- The drafts of the planning offices were not clear to many participants of the process. Therefore, a specific meeting was organized where the planners could illustrate their ideas in more detail than was possible during the initial meeting.
- The bath should also be accessible for people with handicaps. Therefore a meeting with representatives of handicapped persons was organized.

Important results were that the pupils – especially girls – did not want to have sand beneath their feet, and that they wanted to have other sports areas than the boys ("soft ball areas"). Most participants wanted to have a temperature of the water higher than 20°C. About half of them preferred the traditional cleaning of water with chlorine.

The different face-to-face communication events were accompanied by information on a website www.stadionbad.bremen.de and, for 6 weeks, by an online forum. The website was developed by the facilitator with support of one of the authors of this chapter. It is still online and provides the following menu sections (Fig. 18.5):

Fig. 18.5 Screenshot of entrance page of the project_website

1. History of the bath with pictures and information about the development of the location.
2. The two planning-drafts with detailed information including maps, pictures and texts.
3. Technical and hygienic information about the functionality of the two main possibilities to clean the water: the chlorination and the biological cleaning of water. Both measures are explained and the arguments are given under hygienic, ecological, and health aspects, partly underlined by testimonials or longer comments of experts.
4. "We design our swimming pool" covers all results of the different offers of participation, discussions, and excursions. These conclusions were written by the facilitator or the web editor.
5. All decisions are published under this menu point, e.g. results of the support group's meetings.
6. "Scientific consultation" – information about the action research providing *e*-tools to the participation process and about the context of the funded research project. Also presentations within this research project were provided on this part of the website.
7. "Press coverage" with newspaper articles about the whole process and
8. A "legal notice" listing authors, contact details and the person in charge of the website, i.e. the city district manager.

The horizontal menu line offered information about the online forum (during the discussion period, this was the access to the forum; afterwards, its results were provided), a newsletter could be requested, and a contact with the organizers was offered. During the first part also a button “questions to Mr. Wet” was provided to enable visitors to ask questions about complex things related to the renewing process, but this tool was hardly used. Furthermore, after the final meetings had taken place, a partly interactive map was provided with a map of the bath location and information about the specific decisions and arguments for and against important points was offered, together with textual information, pictures, and maps.

At the peak of the participation process, there were about 100 visits per day to the website. After the big advisory meeting, where all results were collected, the interest decreased, also because of the holiday (cf. Fig. 18.6).

The information exchange was supplemented by a text-based accessible newsletter that was published six times during the participation process and three times afterwards: it was sent to approximately a hundred of interested persons by email and to about thirty persons by mail.

In the beginning, great hopes were pinned on the online discussion forum, which, however, were not fulfilled in quantitative respect. The forum was considered a form of communication appropriate for nearly all addressees and, therefore, suitable to function as a continuous common discussion platform where also partial problems could be settled. The idea was that the Patenkreis identified controversial issues, the online discussion forum picked them up and put them up for discussion in subforums, and results were presented to the public (website) and to the Patenkreis for further consideration.

An online discussion forum was offered for about 6 weeks, in which four questions were debated which the support group had identified as being still unclear after the starting event.

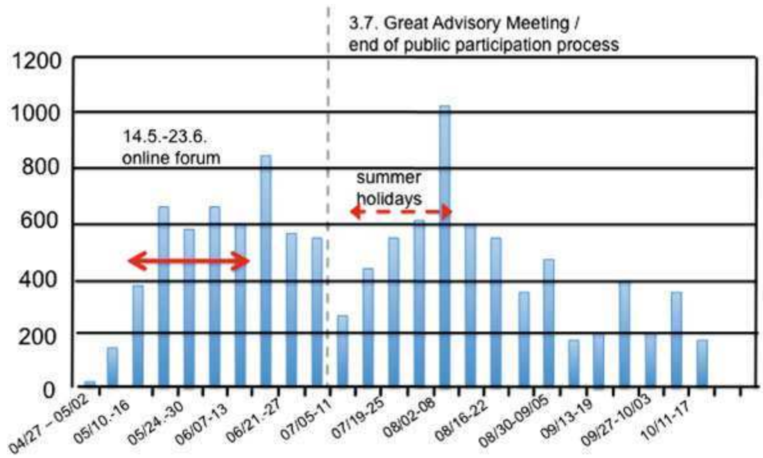

Fig. 18.6 Weekly visits on the project website www.stadionbad.de

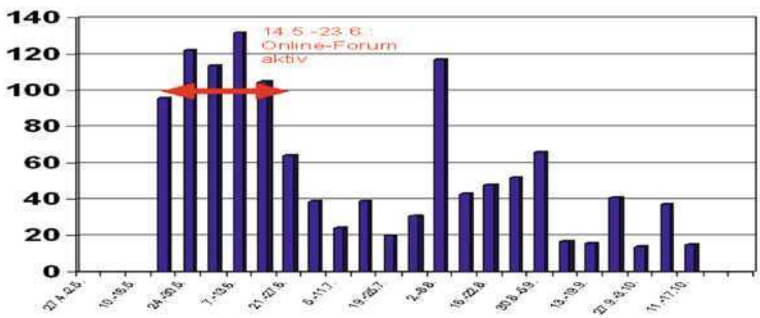

Fig. 18.7 Weekly visits at the online discussion forum

1. Question 1: “Bathing, playing or sun-bathing – how much space for which purpose?”. This part of the online discussion was about the limited space and the different interests to use it and the pressure to negotiate among them, e.g. for a soccer site, a playground or lawn for sunbathing, different pools (e.g. a pool with six 50-m-lanes for sport competitions, a restaurant, etc.)
2. Question 2: “What facilities are necessary?” E.g., a small shop, dressing rooms for individuals or larger rooms, a water slide or a room for playing tools, etc – how much does it cost, and what is really important?
3. Question 3: “Opening times, costs, benefits?”. Which are the best opening times, how much does this cost? Are there ideas on usage during winter?
4. Question 4: “What kind of water do we need?” Here discussions about the quality of the water were welcomed.
5. “Further discussion points” could be addressed by the visitors of the website.

The discussion forum was co-moderated by a team of three interested citizens, two affiliated to the city district administration and the swimming pool, respectively, and. a secondary-school student.

Compared to the strong use of the website, the forum was not much used. About a hundred visitors per week followed the discussions (Fig. 18.7). Fifty, mostly constructive and well-founded contributions, were posted. Discussions among users were rare. In one case, the arguments of the public hearing on water quality (chlorine or natural?) were exchanged on the forum so that also those interested people who could not take part in the panel discussion (or did not understand the arguments) could read them on the forum pages. In another case, the issue of riots of (migrant) youths, which was not discussed in the public meeting, was dealt with in the forum.

18.3.1.1 The Analysing Phase

While the Formulation Phase had the goal of getting as many different views as possible and can be called “divergent”, the Analysing Phase was designed to reduce these views to a few alternatives and can be called “convergent” (Dennis and

Valacich, 1999). For this purpose, the results of the different events were brought together in a second meeting organized by the Patenkreis called the Great Advisory Meeting. Like the starting workshop, this was a 1-day meeting, professionally moderated with the objective to come to an agreement, which would give directions for the planning office which option to follow.

One hundred persons had been expected: about 40 were present most of the day. The Patenkreis had prepared ten boards with the most important issues brought up and discussed in the different participation events including the online discussion forum divided in "consensus" and "no consensus", which were to be discussed in small groups and complemented, if necessary. Possible conflicts were visualized. Each group could give up to three points for each board for the aspects they liked and found important. After lunch, all aspects that had five points or more were brought to the plenary. About five aspects induced lengthy discussions. The main conflict – chlorine or natural – was also discussed and finally a consensus was achieved:

- The controversy about the water could not be solved by a majority vote because it seemed that there were good arguments for both directions and that there was no real majority for one of these solutions. Hence the group found a compromise and decided to have a combination of both types: one large pool with chlorinated water and 50-m-lanes, a second one also with chlorinated water and the jumping tower, and a third pool with a maximum depth of 1.40 m and a large "water landscape" with biologically cleaned water – suitable both for swimmers and for small kids and non-swimmers.
- The temperature of the pools and showers had to be decided: Finally the participants agreed upon usage of solar panels to provide warm water mainly for the 50-m-pool, secondly for the showers.
- To further reduce operation costs, it was decided to use the water of the river Weser directly beside the bath and not drinking water.
- A further point of discussion was the sports ground. The boys argued for a soccer field and most others for a soft ball area (e.g. for beach volleyball). Finally the last was decided because of the danger that others could be hit from a hard ball and get injured. Soccer should be allowed as long as not too many users were lying on the sun bathing ground.
- Bleachers were to be built for sports competition, but also as a resting/sun-bathing opportunity.

The two planning offices received the order to construct further plans on the basis of the decisions of the participants of the "Great Advisory Meeting".

18.3.1.2 Decision Phase

It was the objective of the Patenkreis to come to a "district vote". This vote was in favor of the consensus decision achieved in the Great Advisory Meeting. During the summer holidays, the planning offices worked out their plans according to it. For this purpose they often used the process-documentation on the website. Finally, they submitted their plans on the basis of the results of the participation process. The Patenkreis discussed them and checked whether their details fit the results of the process. At the same time, conflicts with the dike authority (as the pool was next to the dike at the river) had to be solved and led to some financial restrictions. But all these decisions were taken through consensus within the Patenkreis.

The Patenkreis submitted the district vote to the city district council who adopted this vote without further discussion in July 2004. Some government branches who had to agree on certain aspects demanded additional requirements which led to minor changes and small budget shifts. In December 2004, the Sports Deputation took the final decision on the submitted plan. The construction took 1½ years and in August 2006, the Stadionbad was reopened according to plan.

18.4 Process Requirements and Evaluation

In the agreement of the decision-making bodies, the commitment to adopt the recommendation of the district council was based on the condition that certain restrictions are met and that the participatory process is "fair, neutral, consensus- and result-oriented". No doubt the process was result-oriented as it delivered a result, which met the substantial requirements of the agreement. It was consensus-oriented by its very structure and process. And it can be considered to have been neutral, as nobody criticized the Patenkreis or the moderator of influencing stakeholder votes or summaries in favour of a particular option. But was it "fair" as well?

The term "fairness" was not clearly defined, but it seems to be the most crucial condition. In the academic literature, there are several proposals for evaluating participation processes and *e*-participation in particular. Table 18.1 lists three different proposals. While Rowe and Frewer and the Royal Town Planning Institute (RTPI) are looking at any kind of participation procedures at the local level, Macintosh and Whyte and DEMO-net (Lippa et al., 2008) deal with the evaluation of *e*-participation. They propose a three-layered concept including a project perspective, a socio-technical perspective dealing with the *e*-tools, and a democratic

Table 18.1 Criteria for evaluating participatory processes

Rowe and Frewer (2000)	RTPI (2007)	Macintosh and Whyte /DEMO-net
Acceptance criteria		
1. Representativeness	1. Integrity	1. Representation
2. Independence	2. Visibility	2. Engagement
3. Early involvement	3. Accessibility	3. Transparency
4. Influence	4. Transparency	4. Conflict and consensus
5. Transparency process criteria	5. Disclosure	5. Political influence
6. Resource accessibility	6. Fair interpretation	6. Community control
7. Task definition	7. Publication	
8. Structured decision-making		
9. Cost effectiveness		

perspective. In the context of this chapter, we take the democratic perspective only as this relates to the requirements set by the agreement between the political bodies (For the project- and the socio-technical perspective, see Aichholzer and Westholm (2009) and Kubicek et al. (2009) as well).

Looking at the criteria proposed in literature, “fairness” might be interpreted as a combination of representativeness and transparency, which are mentioned in all three proposals. Representativeness means that in the Formulation Phase all different views of relevant stakeholders have been captured and considered in the process. It does not necessarily mean that those participating are representative in statistical terms, of the whole constituency. In contrast to electorates and socio-demographic voters’ research, nobody knows the structure of the stakeholder constituency relevant for the Stadionbad. In quantitative terms, there are 30,000 inhabitants in the neighbourhood of this public swimming pool. Compared to this number, 65 or 40 participants in the two big events form a rather small sample. The website received up to 600 visits per week on average. There were up to 120 subscribers of the electronic newsletter and 50 contributions and 100 visits to the online forum per week.

However, these figures do not question the representativeness of the contributions to the result of the process, when looking from a qualitative perspective. The city district council and the Patenkreis had put together a list of relevant stakeholders, and the decisive indicator is whether these preferences of these groups were adequately represented in the process.

As mentioned before, the strategy was not to wait for these people to come to the events only but also to meet them where they regularly are. This worked quite well with sports clubs, and also with children and students, because one could meet them in child-care facilities and schools. But it did not work with senior citizens and families with small children. And it was not possible to involve migrants in the district with their group-specific interest in family picnics on the meadows of the swimming pool environment. However, the Patenkreis tried to consider and represent the concerns and preferences of these groups. So when finally the city district council had to judge the fairness of the participation process in terms of representativeness, it was the work of the Patenkreis, which led to a positive judgement.

The second criteria, transparency, was met via the different communication channels. Besides the website and the newsletter, there were 32 articles in the two local newspapers, 14 articles in an advertisement paper, and two broadcasts on the regional TV channel. The results of all events mentioned have been published on the website. Transparency contributed to fairness insofar as the publishing of interim results and the final result might have caused critique by people who did not feel adequately represented. But there was no such critique.

18.5 Multi-channel Communication and the Twofold Media Mix

In order to achieve the reported degree of representativeness and transparency, the participation process was not only perceived and managed as a group decision-making problem but also as a communication process with different target groups which have different habits of information gathering via media selection and use. It was assumed from the beginning that electronic means of communication could not substitute face-to-face meetings for achieving consensus, but only complement them. In practice, the participation in the online forum was almost the same as for the two face-to-face meeting events. The widespread assumption that online participation is less time-consuming than attending face-to-face meetings and therefore lowers barriers to participation could not be proven in this case. Reflecting the appropriateness of online communication for different phases, one still might argue that its strength lies in the Formation Phase where many different views shall be collected and divergence is welcome but is less appropriate for the Analysis Phase where convergence is required. But looking closer at what happened in the starting workshop when groups went to the boards of other groups and when the composition of groups was changed in order to discuss divergent positions face to face, one can see that the requirements for the two phases cannot be distinguished so easily and clearly and put into contrast. Although the objective of the starting workshop was to identify different views and preferences, the way this was achieved at the same time provided for mutual understanding and respect of the view of others, thus creating favourable conditions for consensus building in the Analysis Phase and the overall success of the whole process. See **Lourenco and Costa** for further discussion.

This is no argument against online forums in the Formulation Phase. It only reduces their significance to a complementary communication channel. In other words, a multi-channel approach or a mix of electronic and face-to-face communication media is necessary in order to meet requirements of representativeness.

Another argument for a multi-channel approach is the accessibility of electronic media to different socio-demographic groups, considering the so-called digital divide (Kubicek, 2004). As we know that elderly people or migrants have Internet access to a lesser degree, their chance of representation would be lower if an online forum would have been the main entry channel. However, there is the assumption that young people may be attracted to participating in public decision making because of the use of the Internet.

In the case of the Stadionbad, students were considered to be important stakeholders. In the evaluation process, students of the 9th class who were actively involved in the process were asked which source of information they primarily used during the participation process. The most frequent answer was “school”, then with much lower figures “events in the framework of the process” and “student council”. Newspaper and radio were hardly used, and nobody (!) mentioned the Internet and thus the website (cf. Table 18.2). However, this result is in conflict with the feedback given in the Patenkreis (also by youths) that the website was also used by students. These results also show that students had different opportunities to inform themselves. As their teachers were very committed, school was the first and most convenient way to inform themselves. Students who took part in the meetings of the Patenkreis had further information sources.

The website served as a complementary medium, contributing to transparency and, thus, took over a similar role as newspapers, radio, and television. In the original communication plan, it was assumed that the traditional mass media are necessary to create attention and attract people to the primary communication channels such as meetings and online forums by announcing events and reporting

Table 18.2 Preferred information source during the participation process of students of the 9th classes ($N = 45$)

Preferred source of information	Absolute	Percentage
School	29	64
Citizen participation events	9	20
Student	8	17
Newspaper	4	8
Radio	2	4

interim results. Therefore, press releases were issued, and people from these media were contacted by telephone, invited to the events, etc.

The participation process was reflected in the Bremen media, especially in the press (two daily newspapers and two advertisement papers). TV and radio reported once, though shortly. Nearly half of the 48 articles in the period described were published in the most-read newspaper of Bremen. Most articles were less than 100 lines (except five, which showed a photo instead). The linking of most contributions with photos (34 out of 48) probably also increased the attention for the process (and the swimming pool). The media echo had a special effect: the wide response in the newspapers and on the Internet and the fact that many of the addressees could be reached via these media increased the transparency and, thus, the acceptance of process and results. But another consequence was that many of those who should have been motivated to participate did not do so because they felt sufficiently informed and believed that everything was handled correctly.

The website on the Internet was the always accessible "idea pool" of the project: suggestions and results from sub-processes were documented on the Internet so that not only the immediately concerned people could look up the results of their meeting, but also other groups could check how the others proceeded. The newsletter played an important role, because, similar to newspaper articles, it directed the addressees to the website. Peaks of website visits could mostly be observed after a newspaper article referred to the website. For the newsletter, this rule applied only after in a few instances (Fig. 18.8).

Fig. 18.8 Effects of newspaper reports and newsletter issuing on website visits

Moreover, the website was like an archive for journalists and planners who could participate only sporadically and wanted to inform themselves on planning ideas presented a few weeks back.

18.6 Summary and Lessons Learnt

The case of the Stadionbad Bremen is one of only few cases where "real participation" has been offered via a commitment of the political decision-making bodies to adopt the results of the participation process if it meets certain requirements, in particular reaching a consensus as a result of a process with a high degree of representativeness and transparency. In order to meet these requirements, the participation process has not only to be considered as a group decision-making process but also as a communication process aiming at bringing the participation offer to the attention of the stakeholders and motivating them to participate. For this purpose, appropriate communication channels have to be offered posing a minimum of barriers. For developing a communication strategy, it is helpful to distinguish between the primary participation communication and the meta-communication about this in order to maximize outreach and achieve a high degree of representation. At the primary level, this requires a mix of face-to-face communication and online tools; at the meta-level a mix of traditional mass media and a website providing a maximum of transparency. Thus, this example shows that blended participation should be conceived as a kind of double-blending by a twofold media-mix.

The most important lesson to be learned is that "real participation" has to be, for the moment, blended participation, i.e. a combination of online and traditional forms of communication. The obvious reason is that a high degree of representation cannot be achieved by online tools only, as long as the online community is not representative for the whole population or target group. A second less obvious reason is that consensus cannot be achieved only through online communication and electronic tools. Consensus is not the result of preference analysis but demands changes of preferences enabled by mutual understanding between different stakeholders. The case of the Public Swimming Pool shows that such consensus building is possible in moderated physical meetings with changing group composition. Electronic tools could have been employed to a somewhat larger extent but never substituted these physical meetings.

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Part V
Future Prospects

Chapter 19
e-Democracy: The Road Ahead

Simon French and David Ríos Insua

19.1 Introduction

The previous chapters in this book offer little doubt that there are *widespread moves towards public participation* in societal decision making worldwide. The emphasis within the objectives of public participation has shifted since the 1960s and 1970s from the intention to democratise and legitimate policy making to that of involving stakeholders to increase the quality of policy analysis and support for policy making. More recently, theoretical arguments and practical innovations have suggested that including the views of ‘ordinary citizens’ has benefits.

There have been and continue to be many examples of the use of public dialogue and the close involvement of stakeholders and the public in decision making, now intensely supported by the use of ICT. The UK government’s interest in participatory budgets, with all local governments to undertake experiments by year 2012 (UK Government, 2008), signals such pre-eminence. However, there has yet to be a systematic approach to developing guidance on good practice in their use. We believe that group decision and negotiation (GDN) methodologies and technologies may provide such systematic approach. With such perspective, we shall propose a research and practice agenda in this concluding chapter on *e*-democracy and *e*-participation from a GDN perspective.

The global aim of such an agenda would be to develop a general framework for a range of group decision support based participation instruments founded on collaborative decision analysis principles. From these we could choose a specific instrument for a given occasion with the appropriate methodology, deploy it over the web and test it in specific contexts referring to online participation. However, we do not underestimate the difficulties that will arise, not least in identifying which instruments are best suited for particular interactions in a specific participation process.

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In the following, we first describe a generic framework to participation from which we could pick up various participation schemes. We then describe how such a generic approach could be implemented in *e*-participation architectures. We note that there is a need for systematic comparative studies to determine the relative merits of different participation instruments in specific circumstances. Finally, we note some questions in relation with the use of such systems in applications. Generally, we identify a number of research issues that could and, we believe, should keep the *e*-democracy research and development community busy for several years to come.

There is one final qualification before we begin. We have been writing as if an *e*-participation process would necessarily be entirely web-based. It is more likely, however, to be a hybrid or blended process arranging a number of web-based and face-to-face participation instruments throughout the deliberation process; see e.g. **Kubicek** and **Westholm**. That point should be kept in mind in reading the remainder of this chapter.

19.2 A Generic Approach to Participation

As previous chapters have demonstrated, the advent of cheap computing power and almost ubiquitous access to Internet has stirred interest in deploying group decision support tools over the web. This, in turn, has motivated a revisiting of many ideas in group decision support with the emergence of negotiation analysis, sometimes called collaborative decision analysis, as a key methodology; see **Efremov** and **Ríos Insua** for a description. At the same time, there have been trends in the political world to overcome the 'democratic deficit' through more involvement and public participation in societal decision making, in a growing number of cases through web-based interactions. These two developments are converging and we believe that collaborative decision analysis may provide a novel approach and framework to structure *e*-participation applications. Conceptually located between game theory and decision analysis, the emergent field of negotiation analysis (see, e.g., Raiffa et al., 2002; Sebenius, 2006) seeks to develop prescriptive approaches for negotiators and third parties and might be used to great advantage to solve the above challenges, benefiting from ubiquity of Internet.

Indeed, we believe that most of the benefits traditionally attributed to citizen participation could be enhanced through the use of ICT. However, there is a *lack of unified methodology* in the fields of participation and *e*-participation. There are no clear design methodologies for choosing which instruments to include and sequence in a participation process. Instead of seeing the design problem as one of collaboration engineering (Briggs et al., 2003), participation processes are constructed on the basis of poorly articulated experience and intuition (Bayley and French, 2008). Below we suggest that we need to adopt an engineering approach towards the use of the web-based toolbox that would support the implementation and application of participation processes.

In our current thinking, the framework we envisage modifies the standard decision analysis cycle to deal with groups in integrative problems, in which all participants seek to integrate their capacities to attain a common, improved good as follows:

1. *Preparation phase*. At this stage the problem is identified and structured, identifying uncertainties, alternatives, their interrelations, constraints, consequences assessed and criteria with which to evaluate consequences, providing a seed document.
2. *Discussion and consolidation phase*. The seed document would be discussed, debated and consolidated by participants, who would use the common structure at later stages. If uncertain aspects are involved, we suggest using probability distributions modelling the best available science.[1]
3. *Preference communication phase*. At this stage, we elicit each participant's preferences. With this information, each participant may determine his or her optimal alternatives and, more generally, explore the problem. We would also use these for later discussions and negotiations. If all participants obtain the same optimal alternative, we stop. Otherwise, we need to handle a conflict.
4. *Conflict management phase.* This may be achieved either by arbitration or by negotiation and voting or just directly by voting. As far as arbitration is concerned, as we assume that we know the participants' preferences, we just need the corresponding algorithm to compute the chosen arbitration solution. Alternatively, we could use negotiations, which essentially consist of a process in which alternatives are iteratively offered to participants, possibly based on some equitable criterion, until one of them is accepted by a reasonable percentage of participants. Otherwise, no offered alternative is globally accepted, and we may solve the deadlock through some sort of voting scheme.
5. *Post-settlement phase*. If the outcome is obtained through negotiation or voting, it might be Pareto dominated, i.e. socially unacceptable in that all parties could do better without any doing worse: true 'win-win' solutions are difficult to find through simple negotiation and voting. Therefore, participants should try to improve it in a negotiated manner, through a scheme convergent to a non-dominated alternative.

If necessary, we could cycle through one or several of the above stages, until a decision is requisite for the group. A requisite decision is one based on an analysis that is sufficiently detailed and agreed for all to move forward on that basis (French et al., 2009; Phillips, 1984).

Note that in the vast majority of *e*-participatory applications to date, only phases 1 and 2, together with the voting part of phase 4, have been used. As an example, at a recent *e*-Participation Day[2], while many applications were discussed and many *e*-participation systems demonstrated, the vast majority confined themselves

[1] We use 'science' in its broad meaning of human knowledge to include all disciplines.

[2] Organised by the European Commission in Brussels on March 4th 2009: http://ec.europa.eu/information_society/events/eparticipation/2009/index_en.htm

to supporting qualitative debate and deliberation, and voting. Consider also the case studies in our volume. To a certain extent, we could say that, so far, ICT research has focused on facilitating standard political modes, i.e. deploying twenty-first century tools for nineteenth-century political modes. With the above proposal we would expect to help in moving towards twenty-first century political modes. Furthermore, given the large number of different participation methods, such as stakeholder workshops, focus groups, citizen juries, straw votes, referendums and their web-enabled counterparts (see **Lavín** and **Ríos Insua),** there has been little guidance developed on choosing which methods are most appropriate within a particular set of circumstances. A recent report by the Council for Science and Technology in the UK noted:

> Government and other public bodies have started to experiment with using dialogue to inform science and technology based policy. Although these early experiences should be used to inform the approach to future dialogue exercises, enabling government to continually improve its practice, we have been struck in the cases that we have explored by the lack of learning from experiences between and even within organisations.

Thus we need to learn and apply good practice in the design of participatory decision making and deliberative democracy. Indeed, if democratic processes are to be open and auditable, there is a need for a clear, explicit design strategy to build the most appropriate group decision support approach for a given problem. Otherwise, we risk many forms of agenda rigging and manipulability: see, e.g., **Nurmi** and French et al. (2009). This remark applies particularly when we introduce, in addition to the 'standard phases' of participation based on debating and voting, further phases of preference modelling, formal negotiations, and so on. It applies even more to the design of *e*-participation processes, in which it is all too easy to code and implement algorithms whether or not they are appropriate for the purposes for which they are used.

19.3 The Need for a Design Methodology

One issue that has hardly been addressed at all over the past quarter decade is how one should design a participation process. To be frank, most of the work to date has been undertaken somewhat piecemeal. Many individual studies have taken place led by groups with a wealth of experience in facilitating small and large group deliberations. Generally, each study has shown that the participation process employed was in one or more senses better than the more conventional representative democratic processes of government and their agencies, often characterised as 'decide, publish, defend'. But very few have compared different participation processes nor has there been much agreement on what evaluation criteria should be used in comparing different democratic processes, be they participatory, representative or whatever (Bayley and French, 2008, 2010). Without such comparisons, any design methodology for participation processes cannot be evidence based. Undoubtedly, in the early days of exploring new ideas in any domain there is much 'ad hockery' and intuition-guided experimentation, but at some point it is necessary to pass from exploration to scientific evaluation and validation and then to an engineering model of careful design for repeated application. One can argue that those of us working in public participation have spent too long in exploration and need now to move forward gathering comparative data and learning how to design participatory processes that lead to as effective societal decision making as possible.

Drawing on Bayley and French (2008), we may raise the following questions.

1. *What are the objectives in inviting the public to participate in a societal decision*? There has been relatively little discussion of the objectives that should be addressed in designing a participatory process. Bayley and French (2008), drawing on a literature survey, suggest that these objectives can be grouped under five headings: information sharing, democratic ideals, community cohesion, practicability and decision quality. But much more work and wider discussion is needed before we can be clear that we have anticipated all the reasons why participation may be useful in particular circumstances.
2. *How should a participation process be structured*? Figure 1.1 of **Ríos Insua** and **French** suggests that it could be broken down into three phases: issue formulation $\rightarrow$ analysis $\rightarrow$ decision. Other structuring is clearly possible. Is this choice, drawing on decision analytic methodology (French et al., 2009), satisfactory? Are other structures more fitting for societal processes? Moreover, decision analysis is typically cyclic with feedback loops. How many cycles might be expected within a public decision – and should we expect each cycle of a participatory process to be the same?
3. *What are the different levels of participation in each phase*? Resources are limited, as is citizens' time. So it is not possible to involve everybody in every aspect of a decision. In each phase, one has to decide not just which participation instruments to use but also how much effort to put into them: e.g. should 50, 100 or 10,000 citizens be involved? There is a need to consider more carefully not just the phases of a participation process but also how each phase is structured and conducted.
4. *What empirical evidence do we have of the relative merits of different instruments and how may we accumulate more*? We have remarked already on the paucity of comparative studies. We need studies to identify the relative merits of different participation instruments in achieving different objectives in each phase.
5. *Are there interactions between the possible instruments*? It is more than possible that, for example, a web forum with its output feeding into a stakeholder workshop is much more powerful a mechanism than simply the 'sum of the two instruments'. But do we have any idea of all the potential interactions that might be, much less any evidence of whether they exist in a significant sense?
6. *Should the public be involved in the design of the participation mechanism*? If it makes sense to ask the public to participate in a societal decision, then *prime facie* there is a similar case that they should be invited to offer their views on the

design of that process. If so, how? Clearly the primary effort should be focused on the societal decision itself, but are there a range of quick, relatively costless interactions that can enable the public to have input on the design?

Bayley and French (2008) show in their paper how answering these questions would provide the information necessary to implement one design methodology for constructing participation processes. But their approach is based upon a resource allocation decision analytic model. Other approaches are possible, e.g. ones based upon collaboration engineering (Briggs et al., 2003). Different approaches may lead to different questions to those above. But our point remains: we need a much clearer design methodology for constructing participatory processes, and if that methodology is to be evidence based we need many, many more comparative studies.

19.4 From Participation to *e*-Participation

Our remarks in the previous section apply to any participatory process. Returning to *e*-participation, we envisage an online toolbox for building processes which include *e*-participation instruments, as in **Ríos Insua** and **French,** for supporting group deliberations and decisions in public policy contexts, therefore facilitating novel and more encompassing online participatory tools. The toolbox would be generic in the sense that it aims to accommodate several instruments, allowing the user to choose appropriate modules for the application at hand.

Specifically, to use the toolbox one would run through the following stages:

1. A problem owner, e.g. a town hall, has a decision-making problem for which citizen involvement might be desirable.
2. Based on a participatory process design mechanism, as described above, the owner would define the most appropriate participation instruments for each stage necessary to address the given the problem, including whether to undertake such instruments physically or through the web.
3. Using the toolbox, the owner would configure the corresponding participation instruments into a complete process.
4. The participation process would then be run.
5. The problem owner would receive the recommendations of the process and there would also be an audit trail of the process and inputs.

Such a framework and toolbox would embody a novel governance model allowing web-based participation among users to cooperate, share knowledge and facilitate group decision making. By being generic, as defined above, various groups could use it, possibly – indeed, probably – with different participation strategies. Of course, because of the security mechanisms (see, e.g. **Grima** and **Ríos Insua)** there would be a need to safeguard the database against misuse, while ensuring appropriate privacy. The audit trail would increase transparency.

A project could be specified through a workplan which might be specified roughly as follows:

1. Provide a review of participatory instruments oriented towards the included decision-making tasks present in the instruments. This would deepen the description in **Lavín** and **Ríos Insua** by providing an exhaustive compilation of available participation instruments and consulting mechanisms, structuring them according to basic group decision tasks (and algorithms), identification of commonalities and the required corresponding software modules (voting, arbitration,...) and existing (open source) tools already available (e.g., web based voting tools) and identification of new participation methods and instruments
2. Design a generic collaborative decision analysis (CDA)-based group decision support strategy, its foundations and its electronic version. This would aim at providing a CDA strategy for integrative problems, assuming we aim at giving advice to the whole set of participants. We would emphasise the case of large numbers of participants, possibly relying on different analytic methodologies. We would provide foundations for the solution concepts developed. We would also provide algorithms to compute the corresponding solutions for contexts such as discrete influence diagrams, continuous influence diagrams and combinatorial problems.
3. Design an innovative methodology to choose the specific group decision support (GDS) strategy for the problem at hand, based on a generic multi-attribute model. A key issue in choosing the strategy would be choosing the number of participants, their hierarchy and the degree of conflict and coordination. This would aim at providing an algorithm to choose and design the appropriate CDA strategy for the problem at hand, extending the description in Bayley and French (2008). This would require defining a catalogue of possible criteria; defining a procedure to choose the relevant criteria; defining a procedure to evaluate and choose the optimal strategy.
4. Design the generic group decision support toolbox, corresponding to our previous strategies. This would comprise several tasks:

   a. a description of a generic strategy for *e*-CDA from which available instruments (and other more advanced) could be developed;
   b. a description of the architecture to be developed and implemented in a formal language, starting, e.g., from our proposal in **Ríos Insua** and **French;**
   c. the design of the required online participatory tools;
   and last, but not least,
   d. the design of security mechanisms and requirements for the platform, as described in **Grima** and **Ríos Insua**.

5. The next stage would consist of implementing the toolbox, using standard software engineering processes, which would provide us with a platform, plus manual, cases and *e*-learning materials.

6. Perform a political, behavioural and legal assessment of the platform. This would focus on assessing the political and behavioural acceptance of the toolbox, based on case studies. As there might be likely legal impediments with the type of tests undertaken, an exploration on their legal validity should be undertaken.

Our vision essentially supplements the standard methodology of decision analysis (the decision analysis cycle, including different paradigms such as value functions, goal programming and expected utilities) with elements from the negotiation analysis methodology, to provide our framework for collaborative decision analysis. We would implement it on a web-based system with appropriate software engineering methods to provide our participation toolbox. Of course, a key issue would be the implementation. For security, transparency and accountability reasons, we should follow the open source paradigm.

At the moment, we could use technologies such as XML, JAVA, AJAX, GWT (Google Web Toolkit) and try to reuse some of the open source decision support software already available, for example for *e*-voting and *e*-debating, much of which was described in previous chapters. With XML we would improve in issues such as the precision of the information obtained, the agility and communication between remote processes, data independence and intelligent information processing. Through JAVA, we may undertake specific processing of XML information, allowing a general manipulation of all information concerning *e*-participation processes. For that, we could use APIs like DOM or JDOM. AJAX is the main technology underlying the new wave of Web 2.0 web applications. With the aid of AJAX technology, we may improve the interaction between our system and citizens, as it improves interactivity. Finally by using GWT, we can develop an AJAX-based decision support system using Java and Java IDE (such as Eclipse and NetBeans) for better software engineering support. GWT provides a rich set of graphical user interface widgets for us to develop software user interface. It also provides a simple asynchronous RPC (Remote Procedure Call) for developers to access remote procedures on the server side and to pass data objects between client and server. At deployment stage, GWT can compile the client-side of Java code into a standard AJAX application consisting of HTML, CSS, and JavaScript programs. Comparing with systems developing other RIA technologies, such as the Flex-based ThinkTank system and many JavaApplet/Java Web Start based groupware tools that require users to perform software downloading and installation, AJAX-based Web applications can be accessed using standard Web browsers without a need to download and install any software. Therefore, the resulting system becomes easier to access by ordinary users.

19.5 The Art of *e*-Participation

The previous section suggests that building a system capable of supporting a range of participatory processes securely and robustly is a major task, albeit one that seems technically achievable. But building a system is only part of the global approach. If we are to create a valid *e*-participation and *e*-democracy system, we need to use it to implement and support the social processes described in previous chapters. And though building the technology will be difficult, recognising and addressing all the behavioural, cognitive, cultural, legal, political and psychological issues which must be solved to establish valid *e*-participation will, we believe, be much harder. We are concerned that political and commercial imperatives towards the adoption of *e*-participation might lead to their use before we understand what they are actually achieving. We thus identify some of the issues that we should address.

19.5.1 Supporting Large Heterogeneous Groups Through the Web

Meeting on the web is not the same as meeting in a room. Perhaps the first and most obvious difference between the web and a room: interactions on the web can be, and usually are, spatially and temporally dispersed. There is much less chronological ordering of interactions in web-meetings, and many more people can 'speak' at the same time. To some extent, each participant can explore the material in his or her own chosen order, whereas in face-to-face meetings all participants hear and see the same interactions in the same order. There are many sites that can manage hundreds and thousands of two-way and group interactions using *e*-mail, chat and discussion forums. Such technologies could support qualitative deliberations, but we know of none that can handle a similar range of asynchronous interactions in relation to, e.g., the exploration of a quantitative decision model. Asynchronous working in large groups also places a substantial burden on individual participants who truly wish to deliberate and debate with others.

In a web-meeting, pretty much everybody has a computer in front of them and, therefore, can conduct side analyses of the issues, or use the web to gather further information not available to all. In workshops, it is unusual to let participants behave that independently. The emphasis is on sharing information, models and ideas. There is a long and extensive literature on managing and facilitating such processes in computer supported collaborative work and group decision support (see **Carreras** and **Franco** and **Lourenco** and **Costa**). However, at the very least, the methodologies would need modification to cope with much larger groups. Thus a key issue, to be studied in depth, is that there is no *prima facie* reason to expect that the processes, procedures, or agendas developed for face-to-face participation workshops will translate simply in a one-to-one fashion into processes, procedures or agendas for *e*-participation events.

Decision conferences were developed to support groups of decision makers faced with a common set of concerns and issues. Such groups of decision makers do not form randomly but rather, are already working together because of some common interests and objectives. All the GDM modes assume that there is a well-defined group. In contrast, *e*-participation events will draw their participants from across society and they may be self-selecting, therefore being much less likely to have common interests or even common understandings of science, economics, etc. The diversity of the participants' objectives is likely to be greater in *e*-participation than in face-to-face workshops, and the difficulty in exploring decision models and converging to a consensus may be correspondingly larger.

Societies are becoming more multi-ethnic and multi-cultural. This too has serious implications. Different cultures have very different attitudes towards decision making (Hofstede, 1994; Wright and Phillips, 1980). Such differences may occur in decision conferences, but previous joint working experience often softens the edges. Cultural backgrounds also affect the understanding of words and images. Offence is always possible between different cultures by the unintentional choice of words. In face-to-face encounters, body language can help anticipate and recognise such issues as they happen; in a large web-meeting, there may be fewer safety nets. We should thus include different interfaces tailored to the needs of different user groups, some more technically sophisticated than others, say, there is still a question of whether all the interfaces fairly convey the same information and a need to verify whether trust is to be engendered in the participants.

Even within decision analysis, there is far from universal agreement on the validity of different methodologies. We espouse those centred around multi-attribute value models and subjective expected utility. Others do not. This is not merely an esoteric issue that fuels academic debates but may also relate to cultural differences. Thus, structuring *e*-participation around a particular decision analysis methodology may effectively disenfranchise those who find it neither transparent nor, perhaps, rational. Therefore, we believe that an important research issue within this area is to analyse how we may aid in their decision processes to large diverse groups, possibly supported by heterogeneous decision-analytic methodologies. Note that this is acknowledged within our framework, as we allow various modelling approaches within the preference modelling module.

19.5.2 Building Communication Through the Web

French (2007) has argued that a key to making the SEU paradigm a methodology for decision support in large groups dispersed over the web is the development of better means of communicating the reasoning and import of an analysis. Similar arguments may be made for other decision paradigms. Much of the work on public engagement has identified the importance of addressing communication issues, particularly with respect to risk (Bennett and Calman, 1999; Fischhoff, 1995; Gigerenzer, 2002). Despite an enormous research effort, much more is understood about the problems of communication than is known about how to construct effective communication (Maule, 2004). True communication, in the sense of building shared mental models, is difficult even when it is performed face-to-face with all sorts of cues passing between listeners and speakers. On the printed page, in a media interview or, through a web-based discussion, it seems even more difficult.

Note that in spite of the work that has gone on over many years about effective presentation of data and analyses, see, e.g., Tufte (1997), practice is still far from perfect. Within *e*-participation, data presentation will need to be much better. The web is essentially graphical, yet one only has to look at a few websites to realise how poorly we may use its power. We need to improve, and not only in terms of data presentation. While most decision analysts are adept at explaining an analysis and what it is saying either at a meeting or in a report, their audiences have typically been well educated. How decision analyses should be communicated to the general public is still largely an unanswered question.

Secondly, words are not used just with their dictionary definitions. They have local and cultural meanings that some participants may not understand. In face-to-face discussions, particularly facilitated discussions, the meaning of words is negotiated. How that is achieved on the web is far from clear, particularly when the participants are drawn from a wide, politically diverse, multi-cultural society.

19.5.3 The Art of Facilitation Through the Web

In a very real sense, many of the points made above relate to the need for facilitators in a decision conference (**Carreras** and **Franco**). A facilitator is someone with no responsibility or accountability for the consequences of the decision per se, who joins the group to structure, smooth and enhance the deliberative processes. He should be skilled in decision-making tools, group dynamics, psychology, cultural issues and communication and he would use this knowledge to support a group in their work. Facilitation has been fairly well studied in face-to-face contexts but is less well understood in web-based meetings (Niederman et al., 1996; Macauley and Alabdulkarim, 2005). The facilitator's art relates to his or her skill in selecting an effective intervention to move the group's work on in a productive manner and draw on content arising from the group.

Apart from the lack of physical cues to help the facilitator in web-meetings, there is a problem of scale. Decision conferences and stakeholder workshops typically have 15–50 participants, and 100 or more participants would be exceptional. However, *e*-participation could involve thousands of participants. This is significant since the potential for misunderstandings in participant interactions rises as some power of their number. Moreover, it is unlikely that there would be funding to maintain a ratio of facilitators to participants in the order of 1–30 or so. Inevitably, one will be probably working with a hierarchical team of facilitators, bringing further issues of co-ordination and coherence. Clustering methods could help to identify close enough participants and reduce its number, by forming coalitions.

19.5.4 The Issue of Legitimacy and Trust

Let us suppose that all the issues above are successfully addressed and one can create an *e*-participation process to the satisfaction of the facilitators and analysts. Would the public trust it? Would they perceive it as legitimate? There are several levels of trust that we should consider. Would they believe that all the interactions on the website are genuine? Would they accept the analyses on the website as reflecting a set of beliefs and preferences or would they perceive the system as distorting or oversimplifying their views. In a workshop, participants see and hear all the interactions and can count shows of hands themselves; what would give them the same assurance over the web? Any democratic system is subject to some risk of manipulability (**Nurmi**). Will citizens trust other citizens to reveal their preferences honestly in the manner that a decision analytic approach would assume?

There is also a trust issue in the sense of trusting the system to implement an algorithm correctly. Even in the relatively simple area of counting votes, debates in the literature of *e*-voting suggest that guaranteeing that the system transparently adds up the votes correctly is a non-trivial task. How much greater is the challenge with systems that solve influence diagrams with complex probability and utility structures? What quality control is needed to ensure that the results are trusted? Would the code need to be published, even when the models rely on copyrighted or patented decision analytic software? As mentioned above, open source code may well be needed, but it takes time and effort to write and assure quality.

Would the facilitation team be trusted by citizens and politicians? They need to steer the deliberation in some neutral way, discarding irrelevant details to ensure that the decision analysis is tractable. To a great extent, they fix the deliberation rules, but that leaves potential for mistrust. Politicians would have also to accept that such systems could lead to changes in political power structures, with a displacement of responsibility. That may be a step too far for some. But like citizens, they also have to trust the processes and systems.

There is also the issue of legitimacy. Even if society trusts an *e*-participation process to reflect the deliberations of the participants, it does not necessarily follow that it will see it as a legitimate reflection of the whole of society. This relates to issues of the digital divide (Browning, 2002): does each citizen have equal access to the web? We should note, however, that such issues exist for any participation process. They also impose costs such as the need to get time off work or travel costs. Therefore, any participatory process imposes costs and requires overcoming barriers. There are also issues relating to 'fair' representation and the potential for a pressure group to hijack an *e*-participation process. For example, in an attempt to promote participation, we could think of providing incentives for that. However, would these incentives further distort the representativeness of the participants? This is particularly important, since participatory processes may shift the focus of deliberation from issues of science to issues of values, in itself a move for the better (Fischhoff, 1995) but a move that places further demands on the representativeness of those participating.

19.6 Conclusions

As the previous chapters have shown, there is a worldwide growing trend of organisations being involved in participatory processes. Thus, we expect that implementing the above research agenda to be timely, at least, for the large number of municipalities and organisations starting to undertake these experiences. The need to manage such processes well is extremely important, not only in terms of the underlying issues but also in *addressing much of the public's disaffection with political systems*. Besides, a potential success in this area could open the way to incorporating citizens to other sufficiently relevant public decisions.

We are concerned that political and commercial imperatives towards the adoption of *e*-participation might lead to their use before we understand what they are actually achieving. Thus, our aim with this volume has been to bring a number of research questions of outmost importance. These questions should be addressed before the validity and legitimacy of decision analytic *e*-participation can be assessed. There is a need to develop tools and methodologies: to explore, formulate and model issues; to allow unsophisticated users to conduct, or at least explore, decision analyses; to discover and build consensus. We need to understand how to facilitate large, diverse, dispersed, multi-cultural groups, many of whom may share few common values, may be interested in different decision methodologies, and may prefer non-quantitative methods. Without such developments and the answers to the questions raised above, among many others, it is unlikely that any deliberative *e*-democracy or *e*-participation process can be deemed valid and worthy of trust. We do hope that researchers will soon embrace such programs for the benefit of the practice of well-founded *e*-democratic processes.

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