Why good practice of OR is not enough—Ethical challenges for the OR practitioner ☆

F. Rauschmayer[a,*], I. Kavathatzopoulos[b], P.L. Kunsch[c], M. Le Menestrel[d]

[a]Helmholtz Centre for Environmental Research – UFZ, OEKUS-Division of Social Sciences, Permoserstraße 15, 04318 Leipzig, Germany
[b]Department of IT-HCI, Uppsala University, Box 337, SE-751 05 Uppsala, Sweden
[c]MOSI Department, Vrije Universiteit Brussel, Pleinlaan 2, BE-1050 Brussels, Belgium
[d]Department of Economics and Business, University Pompeu Fabra, 08005 Barcelona, Spain

A B S T R A C T

This paper develops the idea that following rules of good OR practice is necessary, but not sufficient for ethical OR. Several challenges of introducing ethical aspects into OR are discussed, evidencing difficulties and ambiguities in the relationship to be established between the OR practitioner and his/her clients, decision-makers or stakeholders. It shows that neither analysis nor modelling work nor the choice of analytical tools is entirely ethically neutral; incomparability, incommensurability and incertitude must be dealt with. The purpose of this article is to detail several difficulties or dilemmas an OR practitioner may be confronted with in the course of his or her assignment. In such situations, following rules of good practice may not be sufficient to indicate how to act in a morally good way. This paper aims at stimulating reflection by structuring the debate; it may leave the reader unsettled—unsettlement being a result and even aim of many discussions in moral philosophy.

Using words from today, one would say that [the management of concentration camps] is a problem of operational research, a frighteningly complex case that considers quantifiable parameters, measured by doctors, and non-quantifiable such as […] the arrival of new deportees inflaming attention or, on the contrary, despair [Boualem Sansal, Le Village de l'Allemand, Paris: Gallimard, 2008 (translation by F. Rauschmayer)].

1. Introduction and scope

In three other papers published in this special issue [1–3], different aspects of promoting Ethics in Operations Research (OR) practice have been developed. Le Menestrel and Van Wassenhove [1] provides an umbrella introduction to all four papers. In [2], it is shown that good practice of OR, with the primary objective of quality control regarding the analyst's work, already includes ethical considerations. Ref. [3] builds on [1,2] and this present paper, and provides recommendations mainly addressed to the OR practitioners on how to use OR methodologies and modelling techniques to approach decision-making problems in which ethical dimensions are present.

Practice of OR is understood in this paper as the interaction between a practitioner and decision-makers involved in solving a specific decision problem in an economic, social and /or ecological real-world system. This problem is understood here as the selection of one specific action within

a portfolio of alternatives on the basis of comparing their advantages and disadvantages. One or several models are developed mimicking the real-world system; results are then fed into decision-support tools to complete the decision-making process. The latter are based, for example, on well developed but sometimes less traditional OR techniques like multi-attribute utility theory, multi-criteria outranking, simulation with system dynamics, agent-based modelling, etc. The real-world models and the decision-support tools are used to assist and to structure the mutual interactions between practitioners and decision-makers about the decision problem.

Good practice of OR first calls for following basic dos and don'ts, and the next section explains several of these obligations. Following good practice, though, does not absolve the practitioner from any further responsibility for actions when practising OR, i.e., when establishing a relationship to decision makers by means of the mentioned models and decision-support tools. The purpose of this article is to detail several difficulties or dilemmas a practitioner may be confronted with in the course of his or her assignment. We have selected those difficulties which appear the most relevant—we do not aim to be comprehensive. Rather than presenting a full story coming from an OR practitioner, the authors relate these difficulties to discussions in adjacent fields such as business ethics, environmental conflict resolution, social ethics or psychological action theory, responding to the call from Müller-Merbach [4]. Confronted with such difficulties following the rules of good practice (see following section) may not be sufficient to indicate how to act in a morally good way. The ethical character of the challenges mainly arises from the effects of OR models and decision-support tools on decisions having impacts on society. This paper places these difficulties with regard to a basic interaction model without aiming at giving easy answers, as there are no easy answers to dilemmas.

Section 2 introduces the basic model and places current recommendations concerning good OR practice in relation to it. Section 3 deals with difficulties when creating models of real-world systems: incertitude, time, scope and the dynamic nature of reality. Section 4 sheds light on the necessary ethical bias when designing decision-support tools due to assumptions made when using any type of such tool. Section 5 presents some of the challenges present in the social relationships between society, decision maker and OR practitioner, i.e. the ability of OR to deal with conflicts, the changing value systems in societies, the role dilemma of the OR practitioner and the limited competence of actors when making decisions. Section 6 concludes this article.

2. Good OR practice

The decision maker is confronted with a real-world problem to which he/she wants to find an optimal or satisficing solution. Therefore, the decision maker calls for support from an OR practitioner who models the main characteristics of the real-world problem, structuring subsequently the decision problem into decision-support tools, comprising of the models' results and preferences of the decision maker.
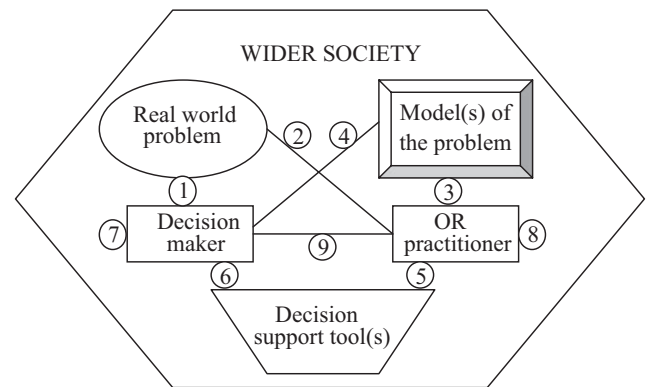

Fig. 1. Basic model of nine ethically relevant relations between different elements in OR practice.

This short, and somewhat schematic story of OR decision support, is depicted in Fig. 1, putting the accent on the relationships between the two actors decision maker and OR practitioner, the real-world problem and its simplified and modelled picture and the tool used by the practitioner in order to support the decision-making process.

Following this basic model (compare [5] for an overview on problem structuring methods, a recent application is [6]), we can differentiate between the following nine element-related relationships and note the most important questions with regard to these relationships:

1. Decision maker—real-world problem: What is the decision maker's perception of the issue?
2. OR practitioner—real-world problem: What is the OR practitioner's perception of the issue? Does it differ from the decision maker's perception?
3. OR practitioner—model(s): Which elements of the real-world issue the practitioner judges crucial and in which way does he/she model them?
4. Decision maker—model(s): Does the decision maker understand the restrictions and contingencies of the model(s)?
5. OR practitioner—model(s): To which degree and in which way captures or co-develops the practitioner the decision maker's preferences and in which way does he/she model them?
6. Decision maker—tool(s): Does the decision maker understand the restrictions and contingencies of the tool(s)?
7. Decision maker—wider society: What are the societal implications of the problem and the solutions, and what are the relations of responsibility and of legitimacy between the decision maker and the wider society?
8. Practitioner—wider society: What are the societal implications of the problem and the solutions, and what are the relations of responsibility and of legitimacy between the practitioner and the wider society?
9. Decision maker—practitioner: Which degrees of understanding, of co-development, of trust and of dependency exist between both actors?

The still seminal work [7], edited by Wallace, entirely focuses on models: model construction and/or interpretation,

value incorporation and ethical responsibilities of model builders, herewith taking up the relationships 1–5, 8 (particularly by [8,9]), and 9. In the following of this section, we focus on Walker's contribution in [2] (this issue). Walker resumes what he considers good OR practice, by concluding "that following the tenets of good practice will assure the ethical conduct of an analyst", and by further pleading for a code of conduct to be developed. The principles of good practice have remained the same between 1994 and 2008: "The work is open and explicit, and its results are verifiable, reproducible, and falsifiable. […] The work is objective. […] Quantitative aspects of the work are treated quantitatively. […] Subjective judgments should be used as little as possible" [2] (italics in the original). By claiming these principles, Walker focuses on the relations 3 and 5 between the practitioner and model or tool, respectively. The claimed objectivity of the model has implications on the relation 9 between practitioner (as an analyst) and decision maker, to be characterized by ethical neutrality. Whenever acting as an advocate, the OR practitioner should mention it clearly.

With regard to problem formulation (relations 1–2 and 5–6), "It is good practice not to accept the client's problem statement as the problem to be addressed" in order not to bias the results. Objectives of all important stakeholders should be included. All possible options should be considered, and the OR practitioner should "withhold personal judgments and withstand political pressures", even when difficult. Due to prevailing uncertainty, "it is good practice to develop several plausible scenarios".

With regard to model building (relations 3–4), the practitioner should construct an understandable model and specify its field of application, its validity being checked with its users. The OR practitioner should avoid the exclusion of possible solutions due to technical properties of model construction. He/she should scope all possibly relevant data, and report on the principles of data selection, and the effects on uncertainty due to data.

With regard to decision making (relations 5–6 and 9), the analyst should maintain the distinctions "between (1) decision aiding and decision making, and (2) between analysis and advocacy". Finally, some of a rather long list of questions, mostly addressing the points mentioned above to a greater detail, also address the relations 7 and 9.

Walker concludes by calling for a code of ethics along the lines of "Code of Ethics and Standards of Practice for Environmental Professionals" [10]

"As an Environmental Professional I will:

1. be personally responsible for the validity of all data collected, analyses performed, or plans developed by me or under my direction…
2. encourage research, planning, design, management and review of activities in a scientifically and technically objective manner…"

3. Difficulties in establishing adequate real-world models

In the authors' opinion, decision processes assisted by OR techniques are to be understood as reengineering attempts aiming at improving the future situation of organizations, or of other human systems. Although the future path of any of those complex systems is partly dependent on the past history, it remains still largely unpredictable because of human freedom. This is a basic difference with physical systems behaving in a fully mechanical way.

OR analysts thus model real-world systems for estimating future developments. These developments are then evaluated by the decision makers, using their own notions of what is good and what is bad. Mostly, the notions of "good" and "bad" are only vaguely defined, and some effort has to be made to make them more precise in any particular situation. An important contribution of modelling with OR is here to help decision makers in gaining more insight, thanks to the development of models of the possible futures, in which their own ethical values are taken into consideration [3,11]. So, it is important to address two issues with OR models: to model adequately the complexity of the system (relations 1–4 of Fig. 1, this section), and to define for future developments what is good and what is bad (relations 5–6, Section 4). Note that, as mentioned in the beginning of this article, the appropriateness of the model also depends on the value system of the decision makers, and might include references to society (relations 7–9, Section 5)—we can only allude to these feed-back loops and not analyze them in depth.

Two basic difficulties, resulting in ethical challenges for the OR practitioner will be discussed in this section: the role of incertitude (subsuming uncertainty, ignorance, risk and ambiguity) and the fact that most OR models are static, while the real world is dynamic. Note that the last aspect is a fundamental source of genuine incertitude, most often to be settled in the "ignorance" category, because (fortunately) the future is never fully predictable.

3.1. A typology of incertitude in the decision process

One of the most important roles that an analyst plays is to assist policymakers in choosing a preferred course of action given all the incertitude surrounding the choice. That incertitude exists in practically all decision situations is generally understood by most decision makers, as well as by the analysts providing decision support. Nevertheless, there is little appreciation for the fact that there are many different dimensions of incertitude, and there is a lack of understanding about their different characteristics, relative magnitudes and available means of dealing with them. In addition, it is widely held that decision makers expect analysts to provide objectivity and certainties [2] and hence dislike subjectivity and incertitude in the scientific knowledge base [12]. In Section 5, we will refer to the more general question of separation between science and politics.

Analytically, incertitude can be split into four main categories according to the knowledge on outcomes and on their likelihood, even if the borderlines between the categories are not clear cut. There are fundamental differences between the different categories of incertitude: risk, uncertainty, ambiguity and ignorance (see Fig. 2).

Risk can easily be handled by defining appropriate distribution functions or probabilities. Once it is known what
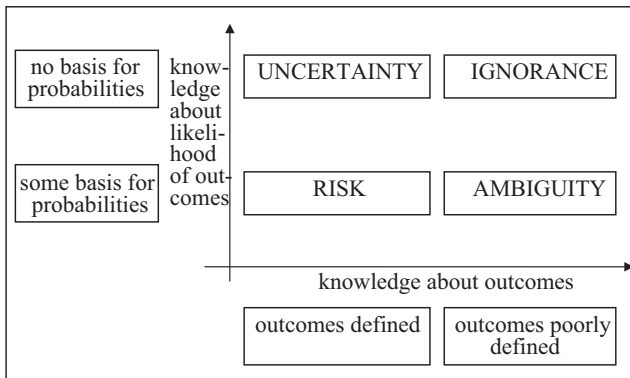
Fig. 2. Dimensions of incertitude, changed from [13].

can happen and with which likelihood an event is going to happen, then this knowledge can be included in models using, for example, the classical economic function of maximizing the expected outcome. When it is not clear what might happen (ambiguity), or how likely an event might be (uncertainty), anticipation becomes more difficult. The best strategy on how to act in these situations depends to a high extent on personal experiences and estimations [14]. Very often it can be seen, though, that uncertainty and ambiguity are denied or transformed into risk in order to integrate it easier into modelling.

With regard to decision making, incertitude in all four categories generally arises in socially or environmentally complex situations [15], and can, according to [16,17], relate to the following four dimensions:

- *Demarcation*: it is not well determined what the options are.
- *Reliance*: it is not clear whether information from others (such as experts) can be relied on.
- *Values*: the values of decision makers or of relevant others are not well determined.
- *Social actors*: it is not clear which actors to take into account and how much importance to give to them.

The first two points are relevant for model building (relations 3–4 of Fig. 1), the last two points relate more to the decision-support tools and the relation to wider society (relations 5–6 and 7–8, respectively).

Uncertainty may be partly reducible to risk, but there remain large areas of knowledge about events and likelihood, which are not predictable (compare on this [18]). This is also due to unclear demarcation of options, such as in nuclear waste issues, where often there is no agreement on what the decision is about or on what the options are. Value- and reliance-related incertitude is larger in areas of novelty, where we do not know which decision could be justified (examples are plenty in the field of new technologies, such as genetically modified organisms, nanotechnology, etc.). Incertitude of social actors grows with the temporal and spatial effects of the decisions to be made: who shall participate in a decision concerning people who are temporally and spatially remote, but concerned by such a decision? And how organize such participation? (Compare on this Section 5 and [3,19].)

Challenges due to incertitude arise in model building, but also in decision support—it is tempting to reduce each incertitude to risk, and it is not easy to define which type of incertitude is present to which degree and what the effects are on models, scenarios, and preference inclusion.

3.2. Narrowing boundaries in dynamic real-world modelling

Modelling real-world systems leaves no other choice than narrowing boundaries in time and scope for being able to deal with the complexity of the problems under focus. The more the considered time horizon is distant, the more the model has to consider uncertainties and also plain ignorance about what will come. It becomes therefore increasingly difficult to define good options: the long-term consequences of present actions are still veiled in darkness. No one is aware, because the battlefield is too vast to overview; too many seemingly not correlated things do happen, like during the battle of Waterloo described by Stendhal, the famous French novelist of the 19th century. A new degree of complexity is added by the frequent long-term consequences of present actions, especially in the globalized technical society.

The scope of influence to be considered in the model has therefore to be narrowed to the point of capturing the main influences relevant for the observed system behavior, and needed for anticipating long-term consequences. Quite often it is difficult to say where to exactly set time and scope boundaries, however. Think of the celebrated "butterfly effect", suggesting that everything interacts with everything in the world. Note that in practice, such a holistic view is not useful for modellers or for decision makers. Modellers are unable to go very far in the level of complication in their models (to be distinguished from the level of complexity, arising in even simple non-linear models), and they have to limit their modelling efforts to the very essential variables and causal links. The existence of closed feedback loops and non-linear influences among the components of systems creates the complexity, i.e., largely unpredictable behavior within even the least complicated systems. Unpredictability and counterintuitive behavior have been largely stressed by Forrester [20], the creator of System Dynamics. Understanding the dynamics within the model and capturing the sources of complexity does not mean that one can make any prediction about the future; it means that one can gain insight into the structures of the analyzed system. The hope is to be able to influence the system in question with adequate policies, for the "good" in the ethical sense (see Section 5 for challenges in defining this "good"). To achieve such aims it cannot be ignored that any decision process is a loop and not a straight line [21]. The first attempt is to gain insight into complex causal influences within dynamic sets of variables. This requires sometimes tedious and time-consuming analyses. Anyway, this clarifying process will always be iterative, because of the previously mentioned dynamic complexities of human systems, and our limited

understanding and identification of key influences at work in dynamic systems.

In contrast to the dynamic nature of real-world systems, most traditional OR models supposed to represent them, and their associated decision-support tools, e.g., Multi Attribute Utility Theory (MAUT) or MCDA, are static. The authors come back to this point in [3]. Those issues of dynamic-system thinking in decision making are thoroughly discussed in [11].

An additional point is the meaning of the models to decision makers. Human mathematics is unfortunately poor in coping with "time". Its time is the mathematical and mechanical Newtonian time. This time is infinitely thin and empty, while "lived" subjective time of human beings is thick and loaded with all kinds of feelings [22]. Subjective time prevailing in human systems is unfortunately out of our reach for OR modelling. Though we are hopelessly embedded in Newtonian time, we should use all the means we have in OR to preserve the system dynamics present in any decision problem. Here again, it is a task of the OR practitioner to build a bridge between scientific models and the value system of the decision makers, linked to subjective "lived" time.

In conclusion, understanding human organizations and their ethical values becomes even more difficult because of the dynamic complexity in structures containing many feedback loops. The challenge for the OR practitioner, becoming an ethical challenge through the impacts of the model on the decision which will have impacts on society, lies in the tension between the understandability of the model and the modelling of complexity and feed-back loops when striving for objectivity.

4. Difficulties in establishing ethical decision-support tools

In this section, we stress two difficulties OR practitioners must confront when introducing or establishing decision-support tools. The first deals with the non-neutrality of OR tools, whereas the second goes into the possible conflict between model assumptions and the decision maker's mind with regard to commensurability and comparability.

4.1. The choice of OR tools and technical parameters is not neutral

Each OR tool makes assumptions about reality, e.g. independence of alternatives, transitivity of preferences, type and quality of the evaluations, rational or ideal form of aggregation of the evaluations. It is obvious that each assumption has an impact on the results of the process, and may therefore constitute an ethical problem if:

- the results are systematically detrimental for specific interests, persons, or groups of persons (consequentialist view),
- the assumptions are not shared by all people concerned with the decision (deontological view), or if,
- the assumptions are selected in a malevolent way (virtue-ethics view).

This problem can be illustrated by the use of MAUT. The basis of MAUT is utilitarianism, and is therefore linked to a specific view on problems and on their solution as algorithm-based maximization problems. This way of thinking is inconsistent with holistic judgments, communicative rationality, virtue ethics or a way of living organized around duties and freedom. Therefore, choosing MAUT as the modelling device has severe implications on the results, and on the inclusion or exclusion of interests, persons or groups of persons (refer to Section 3 for the incertitude linked to values). The same is true for all other modelling devices. There is no systematically best choice, but an ethical problem that has to be cleared up, requiring an ethically conscious decision.

Another challenge, a level below, is the understanding of the different types of aggregation tools according to the use of trade-offs, weights, pair-wise comparisons, aspiration levels, etc. (compare [23]). In existing case studies of OR as a decision aid, value judgments are most prominently captured in the weights, which are attached to the different criteria or groups of criteria. The meaning of the weights, however, differs widely between the different multi-criteria methods. The two main categories of meanings that weights may take are trade-offs (e.g. MAUT), or measures of importance (e.g. outranking methods). The meaning of trade-offs is clear, entailing the assumption of substitutability. Furthermore, substitutability is complete with linear trade-offs, whereas more complex trade-off functions make the aggregation process very difficult to understand. The meaning of measures of importance in outranking methods is less clear. Here, veto thresholds can be introduced easily, restricting the substitutability of criterial values. Substitutability as well as understandability is an ethically important aspect. Substitution is a specific way of making compromises that is not shared by everyone; OR models must be understandable in order to be acceptable.

4.2. Decision criteria are frequently incommensurable

One aim of OR practice is to compare different options (or to state when they are incomparable, see [24: p. 87]). In an analytical proceeding, commensurability of options is a necessary condition for comparability, and is often assumed without any discussion (e.g. in [25]). But the decision situation may comprise criteria, which cannot be reduced to a single overall measure by one decision maker or another. Here, it is the task of the analyst to help the decision maker to make the issue of incommensurability and incomparability clearer, which often is not possible without relating it to ethics.

Following Sunstein [26], the term "incommensurability" will be used as follows: incommensurability occurs when the options cannot be aligned along a single metric without doing violence to our considered judgments about how these goods are best characterized. In many decision contexts, the different criteria relevant for evaluating the options cannot be reduced to a single overall measure ex ante, and this is why we use multi-criteria decision tools. A tool relying on commensurability of the criteria (over) simplifies the value sphere of the decision maker [27].

If decision makers insist on incommensurability and incomparability, then they may have good reasons for this (consider the philosophical debate on incomparability [28,29]). These reasons are personal and necessarily have to do with the decision maker's conception of a good life. For OR practitioners, it is therefore not helpful to maintain an overall image of a decision maker using full commensurability. In order to provide effective help to decision making, practitioners rather need an image of a decision maker's mind, which is flexible enough to account for different conceptions of commensurability and comparability.

Considering these two aspects challenges the practitioner in the following way: it is not enough to be clear about the difference between decision making and decision aid, and about one's own role (analyst vs. advocate), but the selection of the basis of the tool, the use of its internal parameters and assumptions are issues that have repercussions on the decision itself, on the inclusion of values and interests, and on the social dynamics taking place in the decision process (compare [30] on the importance of these issues in conflict resolution).

5. Difficulties in the social relationships

In this section, we deal with three difficulties in the relationships 7–9 of Fig. 1, i.e. the relationships between decision maker, practitioner and the wider society. The first difficulty relates to the social character of many OR problems, and the role of conflicts and violence in them. The second difficulty points to the consequences of decisions on temporally, spatially or culturally distant people, and the challenge of integrating their values or interests in the decision making considered. The third subsection addresses the role dilemma of OR practitioner in relation to decision makers. The final subsection relates to the limited competence of actors to handle moral problems, as defined by their degree of autonomy.

5.1. The existence of present or future conflicts

Most decision-aiding models deal with conflicts. An important part of ethics deals with the fair consideration of interests and values of those concerned by a decision [19]. OR practitioners supporting decision makers to take decisions with social impacts are called to develop models including such considerations (compare [3] on this). Tillett [31: 7–8] defines a conflict as follows: "A conflict arises when two (or more) people (or groups) perceive that their values or needs are incompatible—whether or not they propose, at present or in the future, to take any action on the basis of those values or needs. Thus, while a problem or dispute relates to a specific action or situation (for example, a disputed land claim, the purchase of a motor vehicle, the division of joint property), a conflict can exist without such a specific focus. Two parties can be in conflict because of what each believes, regardless of whether any action has been or is being taken on the basis of the belief". One can roughly differentiate between conflicts on facts, on interests, on relations, and on

values [32]; in praxis, though, usually elements of all four categories are intermingled.

OR is an excellent tool to clarify and address conflicts on data—it can map knowledge (and, to some degree, incertitude), and make clear where people believe to different degrees in the validity of data. OR also can address conflicts of interest through the identification of different decision criteria and different weightings of these (but see [33] on the meaning of weights). OR decision tools can illustrate value differences to some degree by eliciting the differences in criteria weights (compare [34–36]), but is not well equipped to address conflicts due to value differences. Here, an OR practitioner might run into the same temptation as with regard to incertitude: being tempted in the latter case to redefine ambiguity and uncertainty as risk and to leave aside ignorance, the practitioner might try to redefine conflicts on values as conflicts on interests in order to being able to handle them.

In the remainder of this section, we will only deal with conflicts on interests, being more in the focus of OR tools.

Many conflicts on interests have to do with the fight of human beings for scarcely available resources. Often they take the form of social dilemmas, which are ubiquitous around us. Problems of socially ethical behavior can be reframed using the two following conditions [37]:

- social pay-off from "defecting" behavior is higher than for "co-operative" behavior: driving cars instead of bicycles in cities; turning the thermostats higher in dwellings instead of lower;
- all individuals in society receive a lower pay-off if all defect than if all co-operate: car driving creates dangerous ozone pollution in summer time; too much heating in dwellings reduces non-renewable resources in the long term; etc.

Perhaps the most useful and strong metaphor for social (ethical) dilemmas is the famous "Tragedy of the Commons" (TOC)—published by Garret Hardin in Science [38]. This dilemma of overusing open-access resources is present in very many contemporaneous cases at a global level: scarcity of energy and exhaustible resources, climate change, world economic recession, etc. [39].

Humans find different ways to regulate conflicts: the philosopher René Girard [40] gives the name of "Mimesis violence" to the inherent violence and mimetic competition in human societies. In the past, mimesis violence has been regulated by religions. Today we can no longer be satisfied with this approach. The point is to assist public and private decision making in regulating this latent violence. Though conflicts and violent competition always have characterized human societies, they are today exacerbated in our sophisticated world confronted with the finiteness of its natural and social resources (land, soil, food, exhaustible resources, labour, solidarity, etc.) and the ever-growing demand of a society oriented on economic growth (see on this also [3,11]).

Only very few quantitative OR models have been developed so far to give more insight into the mimesis violence, its ethical dilemmas and to propose sustainable remedies.

Again, classical OR is perhaps too conventional to be really useful in this respect. It all too often concentrates on the optimization of short-term problems. Can we change this tradition of OR for the benefit of resolving conflicts?

We stress that, first of all, OR aims at improving the functioning of systems. It could make two important contributions:

- To identify some sources of conflicts and individual violence due to conflicts on interests. The overuse of natural resources is a good prototype present in every human society or organization.
- To propose and to test rules for a more harmonious and co-operative way of interacting e.g., by means of agent-based modelling [3].

OR nevertheless is confronted with the challenge that its ability to deal with conflict is rather limited—it mainly has developed tools to deal with conflicts due to risk or to data interpreted differently missing; to some degree, OR can deal with conflicts due to a difference in interests, and far less due to differing values or value systems.

5.2. Change of value systems over time and cultures

The closer a decision is to our daily life, the easier it is to judge its moral adequacy. In adverso, it is difficult to judge decisions with far-reaching consequences, even more when these are uncertain, concern other humans with different value systems, future generations, etc.

To clarify this, take as an example the two wars in Afghanistan, first conducted by the former Soviet Union, and later by the USA. It is very difficult to guess potential outcomes of such military interventions in a foreign country, and their respective probabilities. Furthermore, it is difficult to evaluate the moral adequacy of such interventions for culturally very distant people, or for future generations. Having in mind the history of OR, it is imaginable that OR practitioners are asked to support the process leading to a decision between different options of military interventions in such cases.

Some people might find some elements of several aspects of these options immoral (for example people following Kantian ethics), some might not have these moral problems as long as the overall benefit is positive (for example some consequentialists, see Section 4.1)—the OR practitioner has to be morally quite flexible in this way. But this is not the point here. The reflections concern the risk of death of persons not participating in the decision, living in the home country as well as in very different cultural contexts. Additionally, this risk depends on various variables difficult to evaluate from one cultural setting. Examples for these variables are: possible pathways of global politics, of terrorist thinking, of hegemony-oriented national politics, of technical possibilities. Everyone sees the impossibility to model reliably this world system, and to come up with probabilities. And everyone should see the impossibility to link these scenarios to ethical values, not only due to the question of life and death implied to it, but due to the

temporal, cultural, spatial distance between the decision maker and the persons affected by the decision.

The difficulty of OR to deal with profound value conflicts (Section 5.1) gains particular importance in decisions impacting on a large temporal and cultural scale.

5.3. The role dilemma in the relationship between OR practitioners and decision makers

On one hand, the OR practitioner must be objective and unbiased as an analyst [2], on the other hand, he or she is aiding a client and is hence biased towards this client, serving as an adviser. Although it is often suggested that the OR practitioner can endorse either one or the other of these two roles [2,41,42], in most situations they combine within the same person. As applied mathematicians, OR practitioners value the scientific method and its striving for objectivity. As suppliers of a service, OR practitioners value the satisfaction of their customers. Hence, there is a fundamental conflict of roles that entails dilemmas for the OR practitioner. How, for instance, can we both formulate a problem exhaustively and respond to the demands of the client? How can a problem be formulated objectively while any language for this formulation already embeds a vision of the world that is far from being value-free? How can this be done if, on top of it, it is suggested to adopt the language and vocabulary of the client? Clearly, the client invariably has his/her own strategic objectives and these may compete with those of other stakeholders. Of course, the analyst can attempt to reconcile private and collective interests, hence solving the dilemma by formulating the problem in terms of a common objective. But this can only be part of the reality. This conflict of roles between adviser and analyst is enforced by the following reflection: if the analysis is intended to be effective, i.e. if it should have a large impact on the decision quality, then it must take into account the clients' preferences, ways of thinking, capacities of understanding in different ways, etc. [43]. Consequently, an effective model has to be biased. It is further illusory to label as "ethical" the attitude of being "non-ethical", for instance when the OR practitioner leaves the advocacy in the decision maker's hands. This "specialization of tasks" raises an ethical issue as soon as one takes the team composed of the OR analyst and the decision maker as the entity of analysis [44]. In other words, this attitude can amount to a denial of responsibility. Who would then be responsible for an immoral decision analysis?

It has been suggested that the ethical dilemma inherent in the role of the OR analyst could be solved at the level of communication, that is by being transparent about the role endorsed [2] and the dilemmas that are faced. It is, however, not without difficulty that the OR analyst will avow the client to have done biased work. Any advocate will have a strong incentive to use the legitimacy of OR as a scientific method to hide this bias and to pretend that the analysis merely reflects the objective truth [45]. Pfeffer [46] for example, observes that in many real life circumstances, experts perform the service of *hired guns* for companion directors or for politicians, justifying preconceived decisions "scientifically" [47]. If the OR analyst does not want to play that role, the client

will do it, protecting the secrecy of the model bias by a confidentiality agreement. Furthermore, communication alone does not solve the dilemma: being clear about the role taken as a "neutral" modeller for an immoral client and communicating this role in an unambiguous way does in no way solve the ethical problem linked with this decision problem [48].

Referring to Section 3.1 on incertitude this can be translated as follows: if the OR practitioner is limited to the role of an analyst, then only incertitude with regard to reliance and demarcation is relevant. Taking on the role of an adviser (or parts of it), i.e. dealing also with the preference clarification of the decision maker and with the inclusion of preferences of further social actors in the process, then the practitioner also has to handle individual and social actor incertitude. As said above, striving for efficient models necessarily includes dealing with these issues.

Although the distinction between and clarification of the role of the OR practitioner as an objective analyst and/or as a biased advocate is useful to clarify the dilemma, it is not sufficient to solve it. Acknowledging the difficult situation is nevertheless a first and necessary step towards any ethically satisfactory decision analysis.

5.4. The limited competence of actors

A successful inclusion of moral aspects in OR analysis, decision making and decision application can fail on at least three levels. First, an OR practitioner may fail to consider relevant moral problems. Second, even when analyzing such problems satisfactorily, the practitioner may not be able to present them to the client in such a way that the client is convinced to incorporate ethical issues into the decision making. Third, decision makers may fail to use properly any ethical information offered to them by OR analysis. The cause of these failures may be found in the way of thinking, problem solving and decision making of both OR analysts and clients. Indeed, people use different ways to handle moral problems. Psychological theory and research [49–51] differentiate between two different moral functions, heteronomy and autonomy. Accordingly, a person's way of ethical thinking, and his/her ability to handle moral problems, is defined by his/her position on the line between heteronomy and autonomy.

To illustrate the difference between heteronomy and autonomy, consider the following problem: a chemical corporation is planning a large investment in an area that suffers from unemployment. Environmental activists demand that the factory should not be constructed due to inevitable chemical discharges, while others welcome the opportunity for new jobs. This is an ethical issue and the president of the concerned chemical corporation may think in a heteronomous or in an autonomous way in his effort to make a decision.

Heteronomy is constrained and authoritarian thinking. Heteronomous thinking is fixed on one or a few general moral principles (e.g. either environmental protection or profits, or something else). Heteronomy means that the president constrains his/her thinking on a single principle while ignoring other principles pertinent to the same problem.

Decision making is not systematically controlled; there is no comparison among relevant principles and possible ways of action. Action follows automatically without reflection. One's own responsibility is avoided and placed on other persons or on general conditions. The preferred solution seems to be morally obvious. Heteronomous thinking does not allow critical and systematic analysis of moral problems; instead, it follows the directives of moral authorities, it tries to ignore the problem and it tries to avoid responsibility. The thought process of heteronomy has no place for questioning. Heteronomy is a decision-making world of ready answers and iron security [52].

On the other hand, the world of autonomy is dominated by asking questions, by a continuous searching of significant missing parts, and of an effort to take control over the situation. Its main emotional characteristics are insecurity and anxiety, which are nevertheless effectively alleviated by the confidence on one's own ability to handle moral issues. Autonomy is a psychological process of ethical problem solving and decision making. The ability to use autonomy easily when necessary lays the ground for higher ethical competence. Autonomy is an ethical matrix in which all alternative ways of treating a moral problem are compared systematically with all values and interests involved in the problem situation. It means structuring in a whole, both possibilities and risks for every probable decision. Through that, a complete picture of the problem situation is created (Fig. 3). The inclusiveness of autonomy, based on systematic and critical analysis, promotes ones own control and responsibility. Autonomy is a process similar to OR analysis, but one that does not necessarily lead to any conclusion, i.e. to an optimal moral solution. Autonomy is the running itself of this psychological decision-making process, as a precondition for higher ethical decision-making ability.

Thus, autonomy as a psychological skill is a positive characteristic both for OR analysts and clients. Moreover, autonomy is useful as a tool to be used in the processes of OR analysis and decision application. In the latter case, autonomy means that these processes should be run in a way similar and in accordance to people's autonomous handling of moral problems, that is, (a) no suggestions or moral prescriptions should be given and (b) an objective and inclusive identification and presentation of all relevant moral aspects should be presented, like the example in Fig. 3, in order to block heteronomy and to facilitate the autonomous thinking and decision-making of the client. However, the use of autonomy as personal skill in OR analysis levels presupposes: (1) an ability on the part of the OR analyst, i.e. ethical autonomy skill to understand ethical thinking and to construct autonomy analyses as a base for the ethical decision-making of the clients, (2) access to ethical autonomy tools, methods and processes like the autonomy matrix in Fig. 3 to be used during OR analysis and knowledge transmission to the client and (3) ethical autonomy skill on the part of the client or decision maker to be able to use properly all autonomous ethical information presented.

In this model, no optimal ethical decision is presented. On the contrary, OR analysts present the complexity of the ethical issue at hand in a holistic, systematic and critical way.

		Possible solutions			
		Invest	Do not invest	Resign your job as president	Other solutions
Relevant values, principles, interests, needs, beliefs, feelings, etc.	Environment protection	Big risks for pollution, but you have to take some measures for protection and you can learn how to combine investments with environmental protection	No new higher risk for pollution but no chance to invest for better environment or learn how to avoid environmental risks with such investments	It may result in a shift of focus to environment but it can also result in hiring a new president who cares less about the environment	…
	Lower unemployment	Positive effects but it may be a catastrophe, if level of pollution rises and leads to closure of the chemical plant	Unemployment stays high, but no risk for disappointment and unfulfilled expectations if investment fails because of environmental risks	You are willing to consider unemployment in your decision, and you do not know whether a new president will be more positive or more negative	…
	Successful investment	Great chance for higher profits but risk for fines or conflict with society	No risk for fines but no chance for higher profits either	You want to try hard for successful investment but you do not know the priorities of your successor	…
	Own conscience	Feeling good about helping people and society against unemployment but feeling bad about environmental and financial risks	Feeling good that you avoid risks for bad environment and fines, but feeling bad that you do not contribute to lower unemployment	Feeling good that you are consistent with your feelings but you feel bad because you do not take responsibility and fight for your principles	…
	Own career	Good for your career, you take the chance and the responsibility, but bad if you show that you do not care about environment	Good for your career, you avoid unnecessary risks and take your responsibility, but bad if you do not work for higher profits	Good, you show that you are a person who has a feeling for important values, but bad if you seem to avoid taking risks	…
	Other values etc.	…	…	…	

Fig. 3. A schematic structure of autonomous ethical thinking applied to the example on a chemical plant investment described in the text (adapted from [49]).

This representation hinders heteronomy while supporting autonomous thinking processes effectively. Whatever final decision the client makes, he/she knows why he/she made it, and what were the reasons behind it. Moreover, he/she can continue a fruitful dialogue with stakeholders, if he/she discloses the arguments for and against any decision to all involved parties. It is also excluded to use this model to justify ethically biased decisions since its structure works against any heteronomy-related bias.

Nevertheless, there may be a difference between OR analysts and clients regarding the degree of difficulty to use ethical autonomy. It would be easier for an OR analyst to

acquire and use the skill of ethical autonomy because: (a) OR analysis is about a problem that belongs to the client and not a personal problem of the analyst causing a mentally positive emotional distance and (b) analysts are trained to perform systematic analysis, and they have a number of effective tools and guidelines at their disposal that may be useful in ethical analysis, too. These two conditions hinder emotional bias and facilitate objectivity. On the other hand, OR analysis, its training and its tools are about problems of technical, economical, political or even psychological nature, but they are definitely not created for analysing moral problems.

Decision Aiding Science according to Roy [53] takes this into account at least partially. Clímaco [54] says: "Decision aiding science may lead to actions with prescriptive characteristics or simply advisory actions, depending on the circumstances. It is an attitude, which frames the decision procedures, in a constructivist view … . In this case, the help does not consist of showing the decision maker or the various actors involved the course to follow, but rather of constructing a set of coherent recommendations that contribute to the clarification of the process. Thus the goals and values of the decision maker(s) do not run the risk of being replaced by any old calculated rationale". Any OR practitioner should help the decision maker to make decisions as autonomous as possible, but is badly prepared for this task by its training and the availability of OR models and tools.

6. Conclusions

Through handling OR models and decision tools, OR practitioners may strongly influence their clients in actually making decisions. They thus have an important ethical commitment in making clear what their models' assumptions are, and the potential evolution of their consultancy propositions on the real-world environment of man and society. This is the most evident condition of scientific and also ethical responsibility. Furthermore, as in all social sciences, models cannot be value-free. They are value laden, and a practitioner is in a permanent tension between the decision maker's values and his or her own values. This knowledge is—or should be—commonplace, but it has to be reflected not only in the singular decision case, but also in the conception of the decision makers' rationality while constructing and implementing decision tools in association with the OR practitioners.

Clarity, openness and outspokenness with regard to values, convictions and roles do not free the practitioner from ethical dilemma situations, though. As we have shown in this article, the relationship between OR practitioners and their clients, the models of the real-world system, decision-support tools and the subject of the decision all can contribute to morally equivocal situations for the OR practitioner. A feature of any human life is that there is no easy way out of these dilemma situations. Difficulties are reinforced by the presence of incertitude, limited competence of actors in dealing with problems, incommensurability in comparing options and relativity in values over time depending on a cultural background. Furthermore, the

complexity aspects in dynamic systems pose a challenge on the suitability of models and tools that are used.

The main ethical issue of the OR practitioner is his/her responsibility: responsibility for what and responsibility to whom? Is the OR practitioner responsible for the decision, for the decision process or only for the models and tools? Is he/she responsible to himself, the decision-maker or to the wider society?

Here, it will not be possible to substantially deal with this issue of responsibility (compare for this [55]). The reader will have noted, though, that the decision tools and models as well as the form of the process influence the final decision, and that, therefore, the objects of responsibility cannot be separated clearly. It has become clear as well that the relationships of the decision maker and of the practitioner to the wider society (relations 7 and 8 of Fig. 1) influence all other relations. All these issues are reflected in the direct interaction (relation 9 of Fig. 1) between the OR practitioner and the decision maker.

We doubt that the rules of good OR practice, as outlined in Section 2, are sufficient by themselves to solve all problems of ethical relevance in the different relationships. Rules of good practice cannot free the practitioner from facing these responsibilities and from dilemmas arising from these responsibilities. Such rules are a good starting point, though, and should be a necessary part of OR practice. To be better prepared to face the ethical difficulties necessarily implied by OR practice, OR practitioners, we suggest, need a better training in ethics, and also in psychology, even if this might involve less mathematical or business training.

Such training should lead OR practitioners to establish their own ethical values, and give them a basis to develop them further in the course of their commitments.

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