Ethical Aspects of Technology in the Multi-Criteria Decision Analysis

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Abstract. In technological systems, decisions are often governed by multi criteria decision analysis (MCDA) techniques that take into account mutually opposing criteria for the system, and it results in ranking of alternatives. MCDA is based on value systems of decision-makers, and ethical deliberation in the process is implicit. We argue that it is necessary to make decision-making in technological systems transparent such that value basis and ethical considerations become explicit and subject for scrutiny of involved stakeholders. As different priorities, value systems and ethical choices result in different technical solutions, such solutions when put in use will promote those intrinsic and implicit values. In a society with ubiquitous technology, value aspects of technology are essential. At present there is no explicit mechanism to expose ethical aspects in these analyses, so they can easily be forgotten. As a support to encourage introduction of transparent value-based deliberation we propose an extended MCDA scheme that explicitly takes into account ethical analysis.

1. Introduction

Modern technology is increasingly ubiquitous and integrated in our everyday lives. At the same time, it is becoming extremely sophisticated and complex, and its development requires taking into account multi-faceted and conflicting preferences and opinions coming from different stakeholders - customers, product managers, project leaders, researchers, system architects, designers, developers, testers, affected general public and so forth. The choice of the "best decision" always requires the trade-off among different objectives. Regardless of the relative importance of the objective itself, it is still up to the decision makers, who evaluate it by introducing a certain level of subjectivity that involves values, attitudes and ethical preferences. We learned from the past errors and we continue to learn from the present how wrong decisions with unjustified or missing ethical perspective have severe consequences for humans and nature. This is valid for decision making in general, from the politics and business, to sciences and engineering domain. As we have experience from software engineering domain, we often chose examples from it. Ethics awareness puts new requirements and demands on the design of techno-social systems, where due attention has to be given to the ethical perspective. Our claim is that value basis for decisions must be made transparent in order to be possible to critically assess and harmonize among stakeholders.

In order to address the above questions, the next section briefly introduces the MCDA discipline as used in technology decision-making. We start by pointing out the subjective and essentially value-based side of decision-making process, in spite of the fact that many assume MCDA to present "perfect rationality".

We discuss the subjective, value-laden and ethical aspects of MCDA and the importance of awareness of those aspects. Finally, we propose a way to augment a MCDA-based design process with ethical deliberation, making value-based ethical aspects explicit and transparent. We conclude with summary of present argument and proposal for future work.

2. Background

MCDA (also referred as Multiple Criteria Decision Aid) is a sub-discipline of operational research and management science, described as "a discipline aimed at supporting decision makers who are faced with making numerous and conflicting evaluations. It aims at highlighting these conflicts and deriving a way to come to a compromise in a transparent process". (Lootsma 1999) It is widely applied in a variety of fields, such as medicine (Baltussen and Niessen 2006), healthcare, environmental planning, forestry (Mendoza and Prabhu 2000), economics and finance (Zavadskas and Turskis 2011), energy management (Pohekar and Ramachandran 2004), transportation (Tzeng, Lin, and Opricovic 2005), public services, marketing, human resources management, and many other fields to support the resolution of decision problems of different nature and complexity (Zopounidis and Doumpos).

Values and subjectivity in the decision process and MCDA

A certain degree of subjectivity is unavoidable in the decision making process, as argued in (Buchanan, Henig, and Henig 1998)(Olson 2009). Inputs to preference models involve subjectivity, weights are function of individual and scores are valued from an individual's perspective. Value is subjective, and closely related to ethics, (Tuana 2015) and it is what MCDA tries to measure. As a consequence, using MCDA methods to solve the decision problem implies that among others the developers/designers and managers subjective values, preferences and ethical deliberations (or lack of them) are affecting the solution.

In view of this subjectivity in the decision process, Kahneman's dual aspect theory provides a good unified model for decision making. It distinguishes between slow (rational, norm-based) and fast (unreflected, emotional) decision making – both of them playing important role (Kahneman 2003). The decision problem in Kahneman's theory is viewed in a new perspective, where the solution is also the consequence of subjective value systems, morals and ethical deliberations. The importance of ethical values and emotions, not captured by the classical model of rationality applied in MCDA has already been pointed out by, among others, (Le Menestrel 2005), (Brugha 2005) and (Wenstøp 2005). We focus on values and ethical deliberation that have much wider and socially relevant effects, compared to emotions that are short term and more contingent.

3. The importance of ethical aspects in the MCDA

In this section we introduce ethical analysis tools and outline the work, which has established that the value basis of MCDA could be viewed through ethical analysis in order to make it visible and open for rational examination.

Technology *with* and *for* society

In the assessment of technology it is important that stakeholders interests are taken into account. "The

grounding assumption is that pluralistic involvement of heterogeneous publics in participatory Technology Assessment (PTA) can assure that decisions are substantively fairer than those that are based upon technical expertise alone." (Cotton 2014) As preferences differ among decision makers, the technological outcomes necessarily depend on their values and preferences. "The integration of values will result in changes of the MCA understanding, criteria building, and aggregation method, and will not be possible without analytical capacities of the decision analyst in ethics. " (Rauschmayer 2001) As an illustration we can mention the framework programme for European research and technological development, Horizon 2020, that have formulated the *Science with and for Society Work Programme*, based on *Responsible Research and Innovation,* where ethical deliberation is clearly visible. In the same vein, we can expect the development of technology with and for society.

What does the ethical deliberation imply? In our case we are interested in applied ethics, which is concerned with a particular application domain of software engineering. Basic documents describing this field of professional ethics are software engineering codes of ethics, such as defined by ACM and IEEE[1] which give some fundamental advice in the field of software engineering, from which further ethical deliberation can start. In the process of ethical analysis, which considers stakeholder's interests and preferences, both intrinsic values (focused on technology) and extrinsic values (focused on the context of technology such as humans and environment) are analyzed. We can learn from health technology assessment, where ethics is traditionally integrated in the multicriteria decision analysis, (Baeroe and Baltussen 2014). Typically, the stakeholder analysis systematization of judgment is made transparent by evidence and values and identification of bias. Here different stages of the process are identified, starting with considering all components of decision, through informing each component of decision consistently, to communicating decisions transparently and supporting understanding and implementation of decisions.

MCDA with emphasis on ethics framework

Wenstøp analyses decision makers starting with the choice of ethics framework (Wenstøp 2005). His focus is on virtue ethics, thus considering ethical decisions as a consequence of a virtuous character, duty ethics, for which ethical decision is a consequence of obeying duties and norms, and consequentialism, for which consequences of the decision must be anticipated in order to decide if it is ethical or not, which leads him to the conclusion that consequentialism and rule-based duty ethics are of immediate importance in practical decision-making, while the virtue ethics acts in an indirect way, through basic attitudes that are underlying ethical deliberation. As value systems in the current setting are largely subjective, Wenstøp argues that "MCDA needs a larger, not smaller, emphasis on values and subjectivity to increase rationality in decision-making". Commenting Wenstøp's analysis, Le Menestrel concludes that MCDA has to be improved in order to capture ethical perspective of the rational behavior (Le Menestrel 2005). Even Brugha supports this account, further developing distinctions between decision makers *needs (physical)*, *preferences (cognitive)* and *values (ethical)*, arguing:

"Probably the most common multi-criteria decision is about making a commitment to a preference in the context of a trade-off between one's needs, preferences and values. Traditionally this has been implemented as cost-benefit analysis, with costs corresponding to the decision-maker's other *needs* that must be taken into account. The *preferences* and the *values* are subsumed into benefits." (Brugha 2005).

[1] https://www.acm.org/about/se-code
http://www.computer.org/cms/Computer.org/Publications/code-of-ethics.pdf

Being *subsumed, values stay invisible.* Our claim is that in technology such as e.g. embedded computer systems, that often is safety critical and mission critical, and always affects us as individuals and society, it is necessary to make underlying values explicit and subject to critical analysis. Brugha argues that "Everything should be refinable: the scores, the weights, and the set of alternatives." (Brugha 2005), while (Beach 1993) argues that "decision makers use three different schematic knowledge structures to organize their thinking about decisions: values, goals and strategies." Values (and thus ethical aspects) are always present in decision making, it is only necessary to make them visible and understand them in the broader context. Technological systems can be designed in different ways, based on the decisions made by their designers and developers. Usually it is assumed that the decisions are objective and perfectly rational. However, as argued above, perfect rationality is far from engineering in real life, which is never perfect, but we can make it as good as reasonably possible. Designers and developers are close to the system and best suitable to understand its consequences. Even though individual engineers cannot always influence the development of the whole system, they can make their insights explicit to other stakeholders. The decision making process in which ethical aspects would be taken seriously, may help preventing problems later on in a techno-social system. This presupposes adequate information sharing and common basic value system in the organisation. In large international and well-organized companies there is a trend to give internal courses on integrity and code of conduct. But this is not so often the case in smaller companies.

What are the factors that might negatively impact the stakeholder's decisions from an ethical perspective? It might be the inexperience of decision makers (Brugha 2005), the so called "groupthink" (Rose 2011; Janis and Vecchio 2007), which might lead to the tendency to establish entrenched positions or prematurely adopt common perspective excluding contradicting information (Rose 2011) as well as errors of omissions. A key factor is organizational learning, which is closely related with the information communication in the organisation. The importance of taking system-level view of decision making process has been emphasized in (Dodig Crnkovic and Curuklu 2012) for the case of another very important application of embedded systems, namely robotics, while (Thekkilakattil and Dodig-Crnkovic 2015) addresses the same topics for the case of cyber-physical systems.

6. Explicating ethical aspects in the MCDA-based development

We propose to explicate ethical aspects during the software design and development decision process, by adding the ethical analysis of requirements, including extra-functional (non-functional) properties. Analysis of the application requirements and project constraints, which requires taking into account stakeholders multiple perspectives explicitly addressing ethical aspects. Responsibility for ethics-aware is necessary starting from an early stage of the development and should be systematically and iteratively negotiated in user-centered (Chilana, Ko, and Wobbrock 2015) and value-centered design (Friedman and Kahn 2013). Designers/developers and other stakeholders have to be involved in this activity in order to avoid neglecting ethical aspects. The main objective of this activity is to aid the decision makers in the elicitation of all of the *relevant properties* related to ethical concerns.

Weight prioritization plays a key role in MCDA and specifically in the final deployment configuration. Several methods to carry out the weight assignments exist as for instance in (Edwards and Barron 1994)

but they do not provide any support from an ethical perspective.

A very recent proposal by Lurie and Mark of an ethical framework (Lurie and Mark 2015) in software engineering suggests including different stakeholders (customer, administrator, team leader, designer, developer) and proposes basic check lists covering different phases in the realization of technology from initiation, requirements, design, to development phase, and testing and verification phase. Even though quality [for a given specification of requirements] is very central value in software development (Sapienza 2014), it is also important to critically analyze how those requirements are decided upon. Particular attention should be paid to the relationships with different stakeholders and their values systems and preferences.

7. Conclusions

As decision-making inevitably includes subjective element in which values, and ethical norms are part of the decision process, we propose to make those aspects visible in the course of design and development of embedded systems, and specifically in the multi criteria decision analysis process. Our claim is that subjective assessment may become more accurate by making values and grounds for choices visible and accessible for critical review.

An initial guidance when addressing ethical implications of different options can be found in codes of ethics and ethics checklists, such as the one given in (Brooks 2008) which successively should be amended by experience-based aspects, preferences, values or scenarios to be taken into account. Central in that process is the organizational learning, which is closely related with the information communication in the organisation. We also argue that system-level view of decision-making process is necessary, as decision-making happens on different levels of organisation. MCDA techniques have been applied in many different domains and we aim to learn from experiences made in other fields and especially health-care sector where ethical aspects are traditionally taken as a highest priority.

The goal of our present work is to point out the necessity of explication of ethical bases for values used in MCDA in technological systems. We aim in the future work to address more in detail concrete procedure that can be applied for ethical assessment of technology through MCDA and to validate the proposed procedure on industrial case study.

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