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Decision-Making and the Information System

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Decision-Making and the Information System

Introduction

The purpose of this book is to question the relationships involved in decision-making and the systems designed to support it: decision support systems (DSS). The focus is on how these systems are engineered; the aim is not to provide a detailed description of various methods or technical tools, but rather to stop and think about the questions to be asked throughout the engineering process and, in particular, about the impact designers' choices have on these systems.

This involves identifying the elements of the problem of decision support systems engineering: the main objects and dimensions to be considered and the relationships they involve, issues at the levels of the decision-maker, the organization (and even the society), the general approach to which to subscribe and so on.

When mentioning the objects and dimensions of decision support systems engineering [SPR 82] highlight that "it is important to recall that the overall system is the decision-making system, consisting of *manager/user*, who uses a *DSS* to confront a *[decision-related] task* in an *organizational environment*" [our emphasis].

This book is organized into four chapters. The first two chapters deal with these four objects (manager/user, decision-making task, organizational environment, DSS), whereas the last two chapters will

discuss the relationships of influence they involve and the need to manage them. A short presentation of these chapters is given below.[1]

The core of decision support: decision-making, the decision-maker and the organization

Chapter 1 will focus on *decision-making*, on the process implemented by the decision-maker, on its position in the life of an organization (three of the components of the aforementioned global decision-making system) and on the latter's environment.

"To decide" means to determine what we are going to do. The verb "decide" is derived from the Latin *decidere*, which literally means to slice, cut or reduce.

Deciding therefore means making a choice (which implies that there are several possible options) and then being *responsible* for this selection. The author believes that decision-making, which cannot be detached from responsibility, is the prerogative of mankind and of mankind alone. To use this term for digital objects (in the broadest sense of programs, agents, robots, etc.) is a misuse of language, which is certainly worth questioning.

There are two main different and opposing approaches to decision-making:

– the first approach, often called normative decision theory, is based on rationality and aims to optimize decision-making by identifying for each situation a utility function that must be maximized [LÉV 89]. The problem is, therefore, considered as given. It should be pointed out that if we agree with the idea of decision-making described above, normative decision theory is not really decision-making at all, as its aim is to produce one (and only one) optimal selection, meaning that all the decision-maker has to do is confirm this choice;

1 Chapters 1 and 2 are partially inspired by Salles [SAL 13].

– the second approach, coming from the work of Simon [SIM 60, SIM 77], takes into account the complexity of decision-making situations and the limited rationality of the decision-maker. Alcaras [ALC 04] called this the theory of decision engineering, in the sense that its object is the global decision-making process (including the definition of the problem) and not only its result, as normative theory suggests. This book explains this approach.

The focus will then shift to the *decision-maker*, who is considered throughout the decision-making process which they use to realize their task, as modeled by Simon [SIM 60] and completed by other authors. The importance of the first phase of the process – i.e. defining the problem – is emphasized. For unstructured or wicked problems, this phase determines the decision made.

Decision-making is an integral part of the life of organizations. As complex systems immersed in moving environments, they must indeed be managed: their principal missions need to be defined, their objectives need to be set, the achievement of the latter should be accompanied and then evaluated and corrective measures are to be decided. The chapter addresses the *organizational environment* of decision-making by modeling how the system (the organization) is managed. The components of the model are described, alongside the dynamics linking them.

Organizational and extra-organizational environments have gone through significant changes over the past 50 years, which have a direct impact on decision-making and the requirements with regard to decision support, in particular for high-level decisions (strategic and, to a lesser extent, tactical). An analysis of these evolutions will conclude the first chapter.

Information systems (IS) and decision support systems

The fourth component of the global decision-making system according to Sprague and Carlson [SPR 82], the *decision support system*, is the subject of Chapter 2.

Originating from systems theory, which considers a business, a state service or a territorial collectivity a complex system, the concept of the IS was created in the early 1970s to differentiate it from the information technology (IT) system. Le Moigne [LEM 73] defines the IS of an organization as a set of significant, formal or informal symbols circulating inside it, assimilating it therefore to a language, i.e. a capacity to take account of the "real" (and/or to construct it) in a way that can be shared by a given community. More recent definitions reinforce this idea by identifying the IS as "a set of social players who memorize and transform representations (...)" [REI 02]. An IS is therefore presented as a system that formalizes representations and that makes these formalizations operational and accessible (and active) through specific codifications.

The IS, which cannot be dissociated from the organization to which it belongs and its environment [MÉL 79], has two main functions [LEM 77]. The first function is to formalize the shared representations that are required for the system to realize its mission, i.e. to produce in the broad sense (Le Moigne refers to this part as the operating system). The second function is to produce representations of the system and its environment which are necessary for managing it (in Le Moigne's terminology, the decision system). These two types of representations overlap only in part.

From an early stage, research has focused on the decision support function of IS [GOR 71], greatly preceding the arrival of specific IT tools.

The IT or digital system is a subset of the IS and it ensures the automatable part of these two functions. From their inception, IT systems have focused on assisting the operating system and, since the 1980s, have made the move toward support for the decision systems to constitute a specific activity sector – business intelligence – and specific tools – DSS.

Chapter 2 will provide an overview of the main definitions of DSS and their evolution through history. Several typologies used to categorize them will then be presented.

A brief history of research in the domain will be presented, showing that after a first period of rich and open research when the problems of the domain were posed in a multidisciplinary approach, a second phase occurred almost totally focusing on technical aspects, and then, faced with certain failings of DSS, in a third period, a new interest arose for decision-makers and their needs, and the role of the decision within organizations. The thundering arrival of Big Data could shift the focus of the domain once again toward technology, as encouraged by the thriving sector of business intelligence.

The chapter will then discuss DSS design with a focus on the requirement engineering phase. This phase determines the organizational objective of the DSS and its content, as well as the type of interaction at work between the decision-maker and the system. It is, moreover, a phase of exchange between all the players in the project and, as such, is essential to ensure the DSS matches its requirements and to evaluate its impact on stakeholders as a whole, the latter being a central point for us.

The impact of the DSS on decision-making and related risks

Chapter 3 will discuss the *relationships* DSS have with the three other objects in the global decision-making system and, in particular, the impact of these tools on the decision-making process.

Research into decision-making has shown the importance of the problem formulation phase [PAR 08], on the one hand, and the determining role mental representations (world views, values, beliefs, etc.) play in this formulation [MIT 97], on the other hand.

First, the chapter will attempt to question the "neutrality" of management tools in general [BER 83] and IS and IT systems (including DSS) in particular. By their very nature, which is to formalize the representations (and thus reduce the complexity of the real), and through their role, which is to make these representations shareable and shared between the players in an organization, the IS produce performative effects. Some tools (e.g. indicators), which

constitute equivalents of the organization's operation, evaluate the latter at the cost of drastically reducing the real.

In the computerized part of IS – IT system – the effects of reducing the real, and performativity, are further accentuated. In view of these effects, we will question the role of DSS in decision-making, in general, and then for the specific type of DSS that constitute Big Data.

The active role of DSS in decision-making will then lead us to consider the risks related to their use. A number of types of risks will be studied: data or processing errors, the risk of confusing the real and its digital representation, the risk of feedback which the performativity of these systems involves and the risk of the loss of diversity in the way problems being asked in organizations are tackled. The biggest danger, which is a result of the aforementioned risks, is that of limiting organizations' *ability to innovate*, as innovation requires new ideas about the organization, its environment and the organization's connection with the latter to be developed. Inscribing in IT system and DSS a unique world view, which is highly restrictive yet undebated (as it is for the most part implicit), also poses the problem of the democracy in the life of organizations.

Finally, the uncontrolled quest for predictive and even prescriptive decision support (which would replace the decision-maker) results, via certain aspects of Big Data and its present or future uses, in disturbing problems at the epistemological and democratic levels. A general and worrying picture is being drawn in the discourse of a number of promoters of Big Data [AND 08, MAY 13]: the refusal of the irreducible diversity of the real, the denial of the necessary complexity of human thought and the devaluation of experience as a primary source of knowledge.

Faced with the immense potential offered by authentic decision support, but also with the real risk of technology that would occultly guide human decision-making, it seems absolutely vital to question the way DSS are built. Their designers, all the stakeholders involved, have a *responsibility* with regard to how DSS are used and to the consequences of any decisions made with their support. By "responsibility", we mean moral responsibility (and not merely

accountability), i.e. a person must hold his/her actions up to his/her conscience and *ethical* values.

Toward ethical DSS design

The recognization of this moral responsibility – which is also economic and social – and its accompaniment are the subject of the fourth and final chapter of this book.

This question, which, strangely, is mentioned very seldom in the literature in the domains of IT systems and DSS, falls into the category of *computer ethics*. Although there has been a concern about ethics since the dawn of cybernetics [WIE 48], computer ethics remains largely absent from IT research and teaching.

A quick state of the art about computer ethics, in general, the ethical theories on which it is based, its objects, the list of values supported, and also its production with regard to IT systems design methods, therefore seemed necessary. From this review, it can be considered that research into computer ethics mostly remains a topic for philosophers, and that research focuses a great deal on topics concerning the individuals (and not organizations) and their use of IT systems in their private life (and not in their professional life). Privacy, accessibility, transparency and non-discrimination are, therefore, the most frequently defended values. With some rare exceptions [STA 10], economic and social questions are not discussed.

Although the ethics of decision-making has resulted in a significant volume of literature, in particular in medicine and in the domain of management sciences, the ethics of DSS remains largely unexplored, in keeping with the computer profession's indifference to ethical questions. Some researchers have got upset about this, such as Meredith and Arnott [MER 03], who note that it is "unfortunate that the ethics of decision support as a specific topic has received very little attention in comparison to the issues of privacy and other general IT ethics issues". The arrival of Big Data has, however, sparked a new

interest in the consequences of its use on both individuals and (particularly public) organizations.

With regard to the aforementioned issues, particularly the limitation of decision-makers' and organizations' abilities by inscribing one single worldview in DSS, which are reinforced by the effects of feedback and the distance from the real, the ethical value we are looking to promote is *democracy*. For us, this involves producing DSS which meet the requirements of democracy, especially the ability to access multiple worldviews.

If we decide to consider the designers and all the stakeholders as morally, economically and socially responsible for how DSS are used, our position can only be upheld if this responsibility is assisted.

As such, we support the creation of *engineering of responsibility* and, with this aim, we will present a methodological tool: the doxai-principles-norms (DPN) model. This model unveils the chain starting with representations (worldviews) and ending with norms (the most operational level), passing through an intermediary level (the structuring principles). The model is destined to accompany the highest phase of engineering requirements – the analysis of early requirements – when the global aim of the future DSS is aligned with the overall objectives of the organization. This phase is essential as it sets the representations (about the organization, its players, objects, etc.), which will form the framework in which the features of the DSS and the ethical values to be integrated will be inscribed. An illustration of the DPN model will conclude this chapter.

Contents

1

Decision-Making

Introduction: decision-making, the central issue of decision support

In an engineering approach to decision support systems (DSS), the technical aspects, however complex, must never forget that *decision-making* is the central issue of decision support. This chapter will explore the different dimensions of decision-making so that we can understand its content, its *sense*.

It is worth reiterating that decision-making is the prerogative of mankind and that a "decision" made by a digital machine is *not* a decision (however, complex, it is nothing but the result of a line of calculations).

Every human being, in their personal and professional life and in their life as a citizen, is almost constantly making decisions of varying degrees of importance. To illustrate (basic) decision-making, let us consider the following: a pedestrian walking from one place to another will decide which route to take, during the journey they will choose which pavement to walk on, where and when to cross the road, how fast to walk, etc., until they decide to stop when they think they have arrived at their destination.

Similarly, decision-making is an integral part of the life of human organizations (authorities, enterprises, the State, etc.). Complex systems are immersed in moving environments, and they must indeed

be managed. Managing takes various forms, but in the end it always results in individuals or groups making decisions. Enterprises must, for example, choose suppliers, organize production, set the price of products, define a client segment, redistribute the tasks of an absent worker, recruit employees and define the axes of research and development, and so on.

This book will focus on the decisions made within organizations, and not those made in individuals' private lives.

Section 1.1 will present two different and opposing approaches to decision-making. The first approach is based on a rational view of decision-making and aims to optimize the final choice. The second approach, taken from research by Simon [SIM 60, SIM 77], takes the limitations of the decision maker's rationality into account and seeks to help them make the most satisfactory decision for them.

In the domain of DSS, decision-making is understood in several dimensions, which can be split into two categories: the first category concerns the individuals making the decisions (the decision makers) and the second category concerns the methods and the roles of decision-making in the life of organizations.

Section 1.2 will focus on the decision maker (or a group of decision makers). First, the decision-making process modeled by Simon [SIM 60] will be studied. Given that the process is partially determined by the degree of formalization of the problems being asked to the decision maker, we will then discuss how decisions are structured (including the specific case of undefined or "wicked" problems). Some specificities of group decision-making will conclude this section.

This book discusses decision-making within organizations; section 1.3 will focus on the organizational context of decision-making. Organizations can be seen as complex systems. Systems theory has presented a management model, which we will describe in detail. Out of its components, indicators play a vital role. A definition of indicators will be provided and then a typology will be presented. We will then reflect on the distinction that must be drawn between