

Organizing Decision Making Processes in Public Administration: The Impact of Knowledge Visualization

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Abstract: The growing complexity of the competitive context imposes on organizations the necessary to make effective decisions in a short time. Consequently, the organization must make decisions on an ever-increasing volume of data and information to increase their competitive advantage. For this reason, the decision-making process must be supported by new tools capable of facilitating and time reduction the knowledge transfer. The public administrations are a particular and very emblematic case. Indeed, public administrations are characterized as bureaucratic organizations with lengthy, often ineffective decision-making processes. The main consequence is a loss of value for the reference community. Hence, improving decision-making in public administrations can have a direct impact on society. On this wise, knowledge visualization by transforming knowledge into different visual tools (e.g., images, tables, graphs, knowledge maps, etc.) can support the decision-making process, speeding up the knowledge transfer process. A growing field of studies is focusing on the knowledge visualization, and on tools to support the decision-making process. The knowledge visualization in complex organizations appears to be a subject that has not yet been fully explored. The objective of this study is to understand the impact that knowledge visualization has on the decision-making process in public administration. In this study the methodological approach implemented has qualitative and exploratory nature. The exploratory nature aims to build the theoretical premises regarding knowledge visualization, the use of knowledge visualization in public administration, and the operational and strategic capacity to support decision-making. The data was collected through the analysis of a case study. This study is part of knowledge management studies, with particular emphasis on knowledge visualization. The results of this study, based on the observation of a case study, offer theoretical reflections on the impact of knowledge visualization in the decision-making processes of public administration. The managerial implications of this study offer an overview of the knowledge visualization tools used in public administration and the impact of knowledge visualization in the decision-making process.

Keyword: Knowledge visualisation, Decision-making, Public administration, Case study

1. Introduction

In recent years, several scholars have highlighted the importance of using diagrams, graphs, schemes, mind maps and social graphs captured in real-time (Berinato, 2016; Miah et al., 2017). The decision-maker can use KV formats (images, maps, etc.) to transform data and information into accessible forms of representations to extract new knowledge and information. Visual representations of information and knowledge have been indicated as a dimension of modern knowledge management to support decision-making process (Miah et al., 2017). Knowledge Visualisation (KV) knowledge visualization is a research area that focuses on the valorisation of knowledge, represented in a visual form. KV can be used at all levels of organizational analysis such as personal, interpersonal, group, organisational and inter-organisational. Public administrations are organizations that have a direct impact on society and on the well-being of the citizen/user. For this reason, they must respond quickly to changes and the growing needs of the citizen/user. The knowledge visualization in complex organizations like public administration appears to be a subject that has not yet been fully explored. The objective of this study is to understand the impact that knowledge visualization has on the decision-making process in public administration. On these premises, this research starts with an analysis of the literature about KV and its formats. It then focuses on the empirical analysis of a case study to offer theoretical reflections on the impact of knowledge visualization in the decision-making processes of public administration. This study investigates KV—through a qualitative and exploratory approach—with the help of two research questions.

RQ1: How does KV support decision-making and knowledge management in public administration?

The remainder of this paper is structured as follows. Section 2 provides a theoretical framework on KV. Section 3 proposes a detailed description of the methodology used to answer the RQ. Section 4 presents the findings and conclusions that are then discussed in section 5, in which the study's limitations and recommended future research are also identified. Finally, section 6 provides managerial and social implications.

2. Theoretical Framework

2.1 Knowledge Visualisation Perspective and Format

The field of Knowledge Visualisation focuses on creating and transferring knowledge through visualisation (Eppler and Burkhard, 2004; Meyer, 2010; Yan et.al., 2011). These authors (Eppler and Burkhard, 2004) presented a widely accepted definition of KV, stating that it *“is defined as a field that examines the use of visual representations to improve the creation and transfer of knowledge between at least two people. Knowledge visualization thus designates all graphic means that can be used to construct and convey complex insights”*. KV has a right impact on the time to make decisions in the knowledge-intensive organizations that need rapid communication. Eppler and and Burkhard (2007, p. 18) proposed a revised definition of KV as *“the subject that studies how to improve complex knowledge creation and transmission between two or more applying visual representation”*. The primary goal of KV is to support knowledge creation and sharing processes. Burkhard (2005) compared Knowledge Management (KM) and KV and concluded that both disciplines are intertwined in efforts towards knowledge creation and sharing. KV is classified as a component of KM, mainly because knowledge transfer is a key process in knowledge-intensive organisations (Burkhard, 2005). Burkhard (2005) proposed a Knowledge Visualisation Model based on the intuition that knowledge cannot be directly transferred from one person to another. The recipients of the transferred knowledge must integrate it into their knowledge according to their backgrounds and experiences. The model is divided into three components. The first component is the “sender” mental model in which the “sender” wishes to transfer a certain part of their knowledge to the “receiver”. Therefore, they externalise their knowledge into visualisations, which are the source for re-creating the “receiver” who tries to internalise the knowledge. In the case of questions or misunderstandings, they can create a feedback loop for the "sender", who must modify their existing views or create new ones to meet the "receiver's" needs. In the second phase, an external visual representation of knowledge must be built to make the recipient aware of the importance of the knowledge. In the last phase concerning the recipient's mental model, the “recipient” focuses on their interests while presenting the details. Finally, regarding the model, it is necessary to answer the following five questions: What is the purpose and effect of externalising visual representations? What is relevant, and should it be displayed? Which audience should be targeted? What are the recipient's interests? What is the most efficient way to visualise knowledge? (Burkhard, 2005, p. 245).

The KV framework includes all graphic means that can be used to build and convey complex insights. The transfer of visual knowledge is complex and challenging as the recipient’s background cannot be distinguished. Visual formats need to be specific, but above all, they need to be consistent so that they can go beyond the details of any individual or group. To become knowledge, information must be processed, meaningful and integrated into the user's mental knowledge structure. In academic literature, KV assume different formats.

KV formats may include a sketch, diagram, map, images, physical model and interactive visualisation (Meyer, 2010). Starting with early symbols, visualisation formats have been designed to improve and enhance knowledge sharing and overcome limitations of time and space (Katuscakova et al., 2019).

For the actual creation and transfer of knowledge through visualisation, Burkhard (2005) stated that at least five perspectives should be considered (Figure 1).

TYPE WHAT?	FUNCTION WHY?	TARGET GROUP FOR WHOM?	SITUATION WHEN?	VISUALIZATION FORMAT HOW?
know-what	Creating	For oneself	In a paper report	Structured text\tables
know-how	Codifying	For another person	In face to face dialogues	Mental image\ stories
know-why	Transferring	For a team	In a speech	Heuristic sketch
know-who	Identifying	Community of practice	In a Mngmt - workshop	Conceptual diagram
know-where	Applying\learning	For all employees	In a expert system	Image\visual metaphor
know-what- it	Measuring\assessing	Specific stakeholders	On the inter\intranet	Knowledge Map
normative k.\value	Signalling	For the public	In a virtual environment	Interactive Visualization

Source: Burkhard, 2005 p. 251; Eppler and Burkhard, 2007 p.113

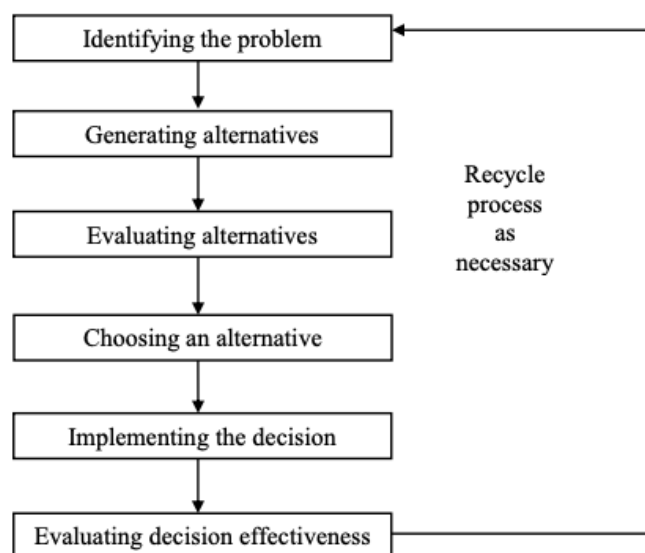
Figure 1: The Knowledge Visualisation Framework

The framework distinguishes six types of knowledge: declarative knowledge (knowing what), procedural knowledge (knowing how), experiential knowledge (knowing why), knowledge about people (knowing who), location-based knowledge (knowing where) and knowledge based on legislation or values (know-what-if). With the help of the function, it is possible to differentiate between different aims for the use of KV, including knowledge sharing through visual means, knowledge creation, learning from visual representations, visual coding of experiences in the past for future users or knowledge mapping (Eppler and Burkhard, 2004; Elouni et al., 2016). The target group perspective, on the other hand, underlines the fact that knowledge visualisation must satisfy the preferences of primary and potential target groups. Their background needs to be taken into consideration, in addition to their expectations when choosing a display format. The situation perspective view emphasises that the use of visualisation depends on the physical or virtual environment and the number of people interacting to manage knowledge.

Finally, the format perspective view outlines the view formats into seven main groups that use media prerequisites as a ranking criterion.

2.2 Knowledge Visualisation in the Decision-Making Process

In an organization the decision-making process is one of the most important activities. It is a process involving choices, and this process generally consists of several steps: identifying problems, generating alternatives, evaluating alternatives, choosing an alternative, implementing the decision, and evaluating decision effectiveness (Schoenfeld, 2011). Two major approaches to decision-making have been identified (Bazerman and Moore, 2013). The rational model characterises decision-makers as completely rational—searching through perfect information to make optimal decisions.



Source: Schoenfeld, 2011

Figure 2: The Decision-Making Process

If a decision-maker were completely rational, they would have perfect information: know all alternatives, determine every consequence and establish a complete preference scale. Moreover, the steps in the decision-making process would consistently lead to selecting the alternative that maximises the solution to each decision problem. Frequently, decision-makers in public administration are not aware that problems exist. Even when they are, they do not systematically search for all possible alternative solutions. They are limited by time constraints, cost and the ability to process information. As a result, they generate a partial list of alternative solutions to the problem based on their experience, intuition, advice from others and perhaps even some creative thought. Therefore, rationality is limited. Herbert Simon (1997, 2009) coined the term 'bounded rationality' to describe the decision-maker who would like to make the best decisions but normally settles for less than the best.

Furthermore, the decision problem may involve relevant problem situations, including physical surroundings, time, requirements and social and technological contexts. During, the decision-making process, decision-makers encounter a variety of challenges, for example, how to gather relevant information in a timely and accurate

manner, how to store, organise and manage the information efficiently so that the resources can be accessed and shared and how to reuse knowledge or experience to facilitate current decision-making (Zhang et al., 2012). The KV formats help decision-makers to see patterns in data that are more difficult to detect through rational methods, improving decisions (Lurie and Mason, 2007). According to Lurie and Mason (2007), the use of KV formats in decision-making shows higher performance, in terms of speed, appropriateness, accuracy and completeness. KV formats that shape and present information more effectively facilitates better communication and supports sense-making (Al-Kassab, 2014). Visualisation can help to support decision-making processes, but it is important to understand its role in terms of knowledge. Visualisation formats can be interpreted as knowledge enablers and could influence knowledge processes such as sharing, integrating and translating (Canonico et al., 2021).

Using appropriate visual representations allows us to present knowledge at a given moment and link it to previous knowledge, facilitating knowledge dissemination for decision-makers and problem-solving. Diagrams, tables and maps are useful for representing precise and indexical information, both quantitatively and qualitatively, supporting decision-making by constraining the set of alternatives that one must consider during a decision-making activity and specifying paths and commonalities among different problem states within an information space (Parsons and Sedig, 2014). Decision-makers need to be aware that KV can enhance knowledge processes and bias them by constraining the attention to a limited set of alternatives, focusing the attention on the wrong variables or encouraging inaccurate comparisons (Al-Kassab, 2014).

KV investigates the use of visualisation techniques to facilitate communication in knowledge-intensive processes and support the creation of new knowledge by using visual techniques. It also explicates, shares or develops knowledge and supports the creation of visualisations for contents that constantly change, such as a process or complex project (Burkhard, 2006).

The emerging field of KV examines the use of visual representations to improve knowledge management on all levels (personal, interpersonal, team, organisational, inter-organisational and societal). It designates all graphic means that can be used to construct, assess, measure, convey or apply knowledge (i.e., complex insights, experiences, methods, etc.). The decision-makers who employ KV aim to create, assess, reference or transfer insights, experiences, attitudes, values, expectations, perspectives, opinions and predictions, and they do this in a way that enables someone else to re-construct, remember, find or apply these insights correctly (Eppler, 2008). This factor is relevant because the visualisations may reduce the cognitive load and enhance the processing abilities by visualising abstract relationships.

3. Methodology

In this study, a qualitative and exploratory methodological approach has been implemented. There are limited studies in the academic literature on the topic of KV and even fewer studies that explain and define KV practices within public administration. The qualitative research approach is appropriate for obtaining a greater description of the phenomenon by the complex nature of the organisations under observation. In fact, knowledge, due to its immaterial nature (Moustaghfir and Schiuma, 2013; Vesperi, et al., 2019), is difficult to capture and observe with different methodologies.

For this reason, the qualitative approach appears more coherent for collecting data or information relative to the indescribable nature of people's understandings, interpretations, feelings or thoughts (Patton, 2002; Ritchie et al., 2003), participants' perspectives and discovering and conveying the delicacy of their responses (Nunes, et al., 2017). The exploratory nature aims to build the theoretical premises regarding KV, the use of KV in public administration and the support decision-making. With these premises, the methodology is based on the analysis of case study. Research based on the empirical observation of a case study allows for a better understanding of a wide variety of aspects of the phenomenon investigated (Gerring, 2007; Vennesson, 2008). The case study structure is useful for fully understanding an organisation in its context (Crowe et al., 2011, Hyett et al., 2014).

The Italian judicial systems are a complex system of a public nature made up of numerous courts, based on civil law. Courts have different specializations. In fact, according to the specialization we can have Ordinary civil and criminal law, Administrative, Accounting, Military and Taxation courts. Analyzing the Italian judicial systems appears very interesting, due to the direct repercussions on the quality of life of the citizen/user. The Italian judicial systems present several critical issues.

Preliminary, the Italian court assume the characteristics of bureaucratic configuration, with numerous hierarchical levels, centralization and pressure on resource management.

Second, the outcome of the judges' decision-making process (judgments) is slow, often hampered by incorrect documents and procedures. For this reason, our analysis focused on understanding the support and use of KV during the judge's decision-making process. A court with jurisdiction in civil and ordinary criminal matters will be examined. The observed case is that of an Italian court. In particular, the study focuses on the decision-making process that the judge applies, within the court, to deliberate a decision (sentence).

Three data collection techniques were used: desk analysis, participant observation and semi-structured interviews (Schiele and Krummacker, 2011). The documentary analysis made it possible to understand and identify the organisational characteristics of the decision-making process. To increase the quality of the material and identify significant consistencies with the aim of the research, a thematic analysis is carried out (Patton, 2002). During the interviews with the decision-makers, experiences, opinions and all the elements for the investigation of the phenomenon were collected. At the end of each interview, the researchers who conducted the interview shared and discussed the interviews' results with the interviewees, based on the approach described by Ricoeur (1986; Kahkonen, 2014; Canonico et al., 2021).

Finally, participant observation was done by the researchers who carried out the field work by accessing the Italian court premises and verifying the KV tools present. This allowed us to acquire relative familiarity with the implementation of their KV tools (Khan et al., 2019).

4. Findings and Conclusions

To understand the implementation of KV within the observed case, the results of this study were collected based on the framework for KV proposed by Burkhard and the model by Eppler (2005, 2007). In fact, using this theoretical framework it was possible to identify and understand the use of KV in the context of an Italian court, explaining the interactions of the decision-maker. KV must be understood as a crucial component of Knowledge Management (KM), with which decision makers can obtain information and thus manage and share knowledge. The results highlighted the use of formats for KV, in different stages of the decision-making process. The first result that emerged from the observation of the case study is that the KV allows to guarantee clarity of data and information, determining greater speed in the transfer of knowledge. Despite this, the KV assumes a marginal "weight". In fact, regulatory impositions lead to a greater implementation of some forms of KV than others. This causes the use of KV tools considered more "suitable" and commonly used.

The complexity of the decision-making process in public administrations, with timing and phases strongly influenced by legislation and the context such as in the courts, characterized by different sources of data and information of different nature.

The decision-making process that determines a sentence is a multi-step process, consequently the use of knowledge visualization allows knowledge to be made accessible, discussed and shared. The reason visual archetypes, containing representations of the real world, are used is because humans could rapidly process images and relate them to prior knowledge already associated with a known image. When you see an image, you know what it represents even if you don't remember the name/concept. It is important that the decision maker is aware of the type of recipient that identifies the target group and the context of the recipient, which can be an individual, a team, an entire organisation or a network of people.

From the observation of the case study, it emerges that the implementation of the KV is strongly influenced by the context and the cognitive background of the recipient to find the right method of displaying the KV. KV offers a systematic approach to the creation, coding, transfer and identification of knowledge at various levels: between individuals, from individuals to groups, between groups and from individuals and groups to the whole organization. To do this, the knowledge must be recreated in the mind of the recipient (El Sawy et al., 1997). This depends on the recipient's cognitive ability to process incoming stimuli (Vance and Eynon, 1998). Once the knowledge is visualized, the decision maker captures feedback from the target audience. Therefore, the responsible person must also convey it in the right context and in a way that it can be used and remembered. The decision-maker, with the help of his own skills and experience, will start a new decision-making process which will lead to the construction of a new view. In this new phase, the decision maker will be able to refine or add more KV formats until knowledge creation, encoding, transfer, identification, etc. is successful. The use of knowledge visualization by all the organizational actors involved in the judge's decision-making process confirms the characteristics of speed and information transfer and the visualization of emerging notions. The use of KV tools emerges from the analysis of the documentation, from the observation of the process and from the interviews carried out, to improve the understanding of particularly complex information and data. In fact, in

the presence of technical data and information, there is a tendency to use KV tools to improve understanding and the risk of information loss.

Some KV tools are preferred over others. The most used tools are diagrams, sketches and images. These KV tools are used to support the transfer of technical knowledge from one organizational actor to another. The main KV tool used are diagrams that allow you to synthesize large quantities of words, making it easier to understand the text. This tool is used to report historical data or future projections. Using different colors, the diagrams make complex information visual and intuitive.

The sketches facilitate the transfer of cross-functional knowledge between different individuals with different professional backgrounds. As we discovered during an interview, the use of sketches encourages reflection and debate between different subjects. Above all it supports the communication process, making explicit and questionable the knowledge in progress, which is generally used to highlight their problem-solving potential.

Finally, images are considered as a "safe and seeking source" of knowledge, as they leave no room for subjective interpretation.

The other knowledge visualization tools (objects, knowledge maps, concept maps and interactive visualization) are not used.

By deepening the analysis on the implementation of visualization in KM it is possible to identify the type of knowledge transferred. The results show that KV allows to transfer knowledge deriving from different sources in a simple and pictographic way. Specifically, KV promotes more effective and faster work and improves teamwork. Better capture staff attention and make knowledge-related work and contributions more effective. However, KV takes longer to prepare, which is rewarded by reduced decision time. In the application of KV, one can explore large and time-varying datasets and allows them to see the behavior of individual data items in the global context of the entire dataset.

The implementation of the visual format has improved the decision-making process as it has allowed the acquisition of cognitive information supported by visual elements.

Knowledge visualizations have been used to explain and answer questions about why, what, who, when and how. The diversity of the target audience underlined that KV has to be adapted to the preferences of the target audience (teaching staff, administrative staff, students, etc.), which then have to be implemented in the different types of KV. Formats can improve the creation, identification and transfer of knowledge.

5. Discussion

The results of this study have provided important food for thought. Visual representations of information and knowledge are the modern dimension of KM (Miah, et al., 2017).

From a theoretical point of view, the results of this study can contribute to the growing debate in knowledge management studies on decision-making problems. In particular, the results of this study highlight the role of visualization to transfer and share knowledge in a new and rapid way, supporting decision-making processes through visual representations. Empirical observation from a court highlighted the complex decision-making process and the role of KV in supporting decision makers. The data collected through interviews with decision makers, analysis of internal documents and participatory observations show that the use of KV has had an overall positive impact, which leads to better communication and better understanding of information and data.

The results highlight the flexibility and adaptability of KV formats in organizations. The different KV formats adapt to the characteristics of the organizations, allowing them to accelerate their decision-making process. KV formats have helped decision makers see patterns in data that are more difficult to detect through rational methods, improving decision making (Lurie and Mason, 2007). Visual representations can expand problem-solving capabilities by allowing more data to be processed without overloading the decision maker (Lurie and Mason, 2007, p. 2).

6. Managerial and Social Implications

This study offers some preliminary reflections on the implementation of knowledge visualisation within the public administration, with particular focus on Italian court. Starting from the assumption that the improvement of the justice system has a direct impact on the quality of life and the well-being of the citizen/user, this study has highlighted the complex decision-making process that characterizes the Italian courts. In particular, the results offer managerial and social implications on the Italian legal system and on the functioning of the judge's

decision-making process. The academic debate within knowledge management studies appears very broad and with numerous fields of application and empirical observation. Nonetheless, the implementation and support of knowledge visualization appears to be an area of strong growth. Above all, there are very few observations from public administrations. Improving and supporting the judge's decision-making process can lead to improvements in the quality of life of the citizen/user.

The preliminary results of this study show that knowledge visualization tools are used by judges to make their decision (sentence). However, some other considerations are necessary. In particular, the complex decision-making process divided into numerous phases, highly formalized and influenced by legislation, limits the true understanding and application of KV. At the same time, the choice and implementation of KV tools can guarantee the speed and certainty of the information and data acquired.

The results of this preliminary study contribute to the academic debate by offering reflections to start future research on public administrations and to understand its real impacts on the implementation of the KV.

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