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**EFFECT OF THE KNOWLEDGE REPRESENTATION FORM ON THE
EFFICIENCY OF KNOWLEDGE SHARING**

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ABSTRACT

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The goal of this thesis is to estimate the effect of the form of knowledge representation on the efficiency of knowledge sharing. The objectives include the design of an experimental framework which would allow to establish this effect, data collection, and statistical analysis of the collected data.

The study follows the experimental quantitative design. The experimental questionnaire features three sample forms of knowledge: text, mind maps, concept maps. In the interview, these forms are presented to an interviewee, afterwards the knowledge sharing time and knowledge sharing quality are measured. According to the statistical analysis of 76 interviews, text performs worse in both knowledge sharing time and quality compared to visualized forms of knowledge representation. However, mind maps and concept maps do not differ in knowledge sharing time and quality, since this difference is not statistically significant. Since visualized structured forms of knowledge perform better than unstructured text in knowledge sharing, it is advised for companies to foster the usage of these forms in knowledge sharing processes inside the company. Aside of performance in knowledge sharing, the visualized structured forms are preferable due the possibility of their usage in the system of ontological knowledge management within an enterprise.

АННОТАЦИЯ

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Целью данной диссертации является исследование влияния формы представления знания на эффективность обмена знаниями. В задачи работы входит построение экспериментальной схемы, при помощи которой возможно установить данное влияние, сбор данных, а так же последующий статистический анализ собранных данных.

В диссертации автор использует метод эксперимента, а так же количественные методы исследования. В экспериментальный опросник входят три формы представления знания: текст, диаграмма связей, концепт-карта. Во время интервью автор измеряет скорость и качество обмена знаниями. Анализ данных показал, что при сравнении с визуальными формами, характеристики скорости и качества обмена знаниями хуже всего у текста как у формы представления знания. В то же время, разница между данными характеристиками у диаграмм связей и концепт-мэпов не является статистически значимой. Так как структурированные визуальные формы представления знания эффективнее текстовой формы, компаниям предлагается развивать использование визуальных форм при обмене знаниями внутри компании. Кроме эффективности, положительной стороной структурированных визуальных форм является то, что их можно использовать в качестве основы для онтологической системы управления знаниями.

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This thesis is the end of hard yet exciting master degree studies. During these two years my main goals were to learn new things, improve my skills, acquire any knowledge which will help me to understand life better and be successful in my career. I can confidently claim that these goals have been achieved, and I learned more than I could expect. I am thankful to all the individuals and institutions which helped me during this road.

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Sincerely yours,

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1 INTRODUCTION

Knowledge is the resource, which becomes more and more important in the postindustrial era. Needless to say that knowledge can be one of the main competitive advantages of the firm (Porter 1985). Knowledge management is the discipline, which makes the use of knowledge in the corporation efficient. This discipline encompasses many subfields; it gives priority to some while providing less attention to others. The fields of knowledge management, which are in the focus of attention of this study, are the management of explicit knowledge and knowledge sharing. Explicit knowledge, as opposed to tacit knowledge, is the kind of knowledge that is visible and can be expressed and transferred from one resource to another (Nonaka and Teece 2001). It is also usually stored in some comprehensive format, so it can easily be communicated to others through forms such as documents or concept maps. On the other hand, tacit knowledge is the kind of knowledge which is known only by an individual, and it is difficult to transfer it to other individuals or instances, since it is not codified and there might be issues expressing it.

Explicit knowledge and its form become more and more important due to information overload which becomes more and more severe as the post-industrial era develops further. The problem is not just the personal inconvenience of individuals who have to face vast amounts of unstructured knowledge; it also has an effect on the costs of companies. For instance, the total negative impact of misconsiderations of information value on the U.S. economy has been estimated to be nearly \$1 trillion (Hemp 2009). This means that knowledge should be structured and delivered to managers in such a form, which would ensure easy sharing and retention of knowledge after the knowledge sharing process.

Aside of the difference in efficiency during knowledge sharing, structured and unstructured forms of knowledge are different on a deeper level. When knowledge is structured, it is possible to map this knowledge using a set of common definitions and principles. This conversion to a mutually agreed upon and shared by all participants format of knowledge allows to create the system of knowledge management within an enterprise on the basis of ontologies. Organizational

ontology is a computer system within an enterprise which makes it easy to access, store and share knowledge. This type of knowledge management system within an enterprise is the most efficient as it removes all inefficient (e.g. paper-based) knowledge sources, thus it can help the company operating such a system in the economic competition. However, this type of knowledge management system is complicated and it requires properly trained employees, since in such a system knowledge should be converted into a mutually agreed upon form. Thus, if the structured forms of knowledge are better for knowledge sharing than unstructured forms, it adds not only to the plain efficiency in time or quality of knowledge sharing, but the usage of these forms might also be the first step towards the ontological knowledge management within an enterprise.

Knowledge sharing is nothing but a process in which knowledge has been shared and eventually received and learned or used by a recipient (in the context of this work, a manager). Knowledge sharing and explicit knowledge merge in the thesis, thus providing the scope of the study, which is the effect of forms of explicit knowledge on the knowledge sharing practices.

Although there was some research on the issues of knowledge sharing and the factors, which can hinder or foster it, there is little or no comprehensive research on how do the forms of knowledge affect knowledge sharing in one of the important bottlenecks of the company, in knowledge sharing among managers. This study is aimed at closing this gap.

Research problem: The effect of the form of knowledge on the efficiency of knowledge sharing.

Research question: Which form of explicit knowledge has the best time and quality knowledge sharing properties in knowledge sharing with managers?

Research objectives:

- To outline the experimental framework which would be suitable for the assessment of the effect of the form of knowledge representation on the efficiency of knowledge sharing

- To collect data on the performance of different forms of knowledge sharing from Russian and Finnish business school students as a proxy for managers.
- To conduct an experimental study and establish the most performing form(s) of knowledge sharing.

The study is experimental, and the topic is not researched quite well, so the results are unpredictable. However, this study aims to outline the form of knowledge, which is the easiest for the managers to comprehend, if there is one. This means that if there is a form like this, and the results are conclusive, it is advisable that the companies should foster knowledge sharing in the respective most efficient form(s).

The study is not supposed to review all topics, related to knowledge representation forms, it is only supposed to review the part, which is directly connected with the research question. Aside of that, the study will not establish the form of knowledge sharing which is absolutely efficient in every situation, since the organizational context still plays a big role in efficiency of knowledge sharing. Another limitation is that the target population of this study consists of business school students, which places some restrictions on conclusions which can thus apply to younger managers of 20-30 years of age.

2 LITERATURE REVIEW

2.1 Knowledge and knowledge management

According to Alvin Toffler (1980), the world went first from the reliance on agriculture to the industrial era, which achieved its peak in the beginning of XX century. At this state of economic development, mass production of the goods became the mainstream way to satisfy demand and thus provide goods and services to the society. However, this way of production has also reached its peak. It happened in the second part of the XX century, when the so-called “commoditization” has reached such a stage, when not the actual production, but the flows of information which surround it became important. In the end, according to Toffler, it led to the age of knowledge, when it became the most crucial resource of the business (Toffler 1980). Toffler’s ideas become more and more relevant as more and more of organizations are looking into the resource of knowledge due to all benefits which wise handling of knowledge might bring.

Knowledge itself can be defined as “justified true belief” (Nonaka et al. 2006). Knowledge has to be distinguished from information and data. Data is a massive of unstructured facts (Avison and Fitzgerald 1998), which can describe anything. In turn, information is something which is more sophisticated than data, it is data interpreted, some fact. These are different, yet related concepts. Knowledge is the most sophisticated concept. Basically, knowledge is a product, derived from information, it is information refined. Knowledge is the result of deep understanding of the information, and, unlike information, it provides a conceptual framework for the understanding. According to Davenport and Prusak (1998), knowledge is more about experiences and values, which enable organizations and individual to evaluate, generate and incorporate ideas and information.

Knowledge has been out of the scope of business research for a long time, but with the rise of computer science and information technology in the era of information, knowledge made a reappearance for the business researchers. It appeared both as a concept from information technology and as a managerial

concept within business science, for instance in the form of knowledge-based theory of the firm (Grant 1996). Currently knowledge is becoming yet a hidden, but already an extremely important component of an enterprise, which has been appreciated by distinguished business researchers, e.g. (Porter 1985) (Drucker 1999). Porter in his seminal study on competitive advantage mentioned knowledge as a driver for creating and sustaining competitive advantage (Porter 1985). Knowledge supports business processes and the strategic directions of a company (Quinn 1992). Aside of that, knowledge adds to the long-term sustainability of an organization (Eid 2009).

Knowledge within the company is called organizational knowledge. It is created within an organization with the help of experience, expertise and knowledge of individual minds, and when it is put into context, it can be actionable and it can provide value for the organization. Such renowned researchers of knowledge management as Nonaka and Takeuchi (1995), King et al. (2002) called for control and balance of organizational knowledge in order to extract all potential from it.

The notion of organizational knowledge stems from the seminal work of Shumpeter (1934), which discusses an idea that knowledge exists as an outcome of individual and collective experience. Knowledge in the organization can be created by an individual, by a group, or be imported from within an organization. While individual knowledge belongs to a single person, group knowledge is created within multiple individuals, which create, rely upon this knowledge and share it among themselves. With the exchange of knowledge within the group, individual knowledge synthesizes into group knowledge. The company might also import the knowledge from other organizations. This knowledge can be either directly imported, or generated through a collaboration with other companies.

Another concept related to the knowledge within an organization, which is focused on the value which knowledge brings, is called intellectual capital (Stewart 1997; Edvinsson and Malone 1997). The key point of intellectual capital is that knowledge is created through the exchange of information within an organization. According to Edvinsson, intellectual capital is a search for relationships among people, ideas and knowledge. Intellectual capital is therefore a relationship

concept, it is a renewable as well as renewing resource, that must be cultivated in a context. The management of intellectual capital is a process that can be facilitated, but which is not easily controlled, since it is a network of connections (Edvinsson 1997).

There are various approaches and definitions related to the management of knowledge. The seminal definition of this discipline is claims that knowledge management is the process of capturing, developing, sharing, and effectively using this extremely important organizational knowledge (Davenport 1994). Main objectives of knowledge management in organization are to achieve knowledge growth, knowledge communication and knowledge preservation in the organization (Gomez-Perez et al. 2004). It cannot be done without proper means of knowledge management due to tremendous amount of knowledge contained in modern organizations. Wig (1993) made a clear differentiation between what knowledge management is, and what it is not. According to him, knowledge management is:

- A management philosophy that takes explicit advantage of knowledge to make the organization act more intelligently.
- A management initiative that views and understands knowledge as it is used in operational situations and for long-term strategic improvements.
- Ways to find, analyze, focus on critical knowledge areas, associated management opportunities, and ascertain that proper knowledge is available wherever needed.
- Methods to allow managers identify and characterize knowledge contents, needs, and opportunities associated with specific operations.

According to the same article, knowledge management is not (Wig 1993):

- A set of isolated techniques without a common framework.
- A different label for human resources management and training.
- A standardized methodology for “how to” knowledge management.
- A different name for “expert systems.”
- A set of computer application programs.
- A system to control distribution and security of knowledge.

Knowledge management is focused on acquisition, structuring and usage of knowledge. These parts of knowledge management are entwined, since acquisition contributes to the amount of knowledge stored, structuring makes it easier to access knowledge, and both foster the usage of knowledge. Practices of knowledge management allow for socialization, externalization, combination and internalization of knowledge, which helps to create better organizational knowledge (Nonaka et al. 2001).

These processes of knowledge management are summarized in the concept of knowledge life cycle model. There are several models of knowledge life cycle, for instance Awad and Ghaziri (2004) present a model which consists of 4 stages:

- Knowledge capturing
- Knowledge organizing
- Knowledge refining
- Knowledge transferring

According to models of knowledge life cycle, knowledge flows through the interactions inside an enterprise and it follows several stages of development. The part of knowledge management process which is the focus of this thesis is the effect of the knowledge form on knowledge sharing, and thus, the most important stage of knowledge life cycle for this research is the stage of knowledge organizing. After the knowledge has been captured, knowledge is organized in some form, where it can be indexed, clustered, catalogued, filtered or codified (Awad and Ghaziri 2004). At this stage the knowledge can be transferred to some form, which will thus have an effect on knowledge management practices within an enterprise.

Another contemporary model of knowledge life cycle is presented in Sagsan (2006). According to this model (Figure 1), knowledge goes through five main stages of creation, sharing, structuring, using, auditing. This model reviews knowledge sharing as a more technical notion, as it regards this process mostly as social and technical communication infrastructure. However, the state which has the most relevance to this work is the knowledge structuring stage. According to the author, in this state the knowledge is mapped, stored and then retrieved.

During the mapping state, the knowledge can be embedded into any knowledge form, and this is the scope of the study to find the most appropriate form of knowledge sharing. Aside of mapping the scope of this research in the framework of knowledge management within an enterprise, knowledge life cycle model generally helps to assess the basic procedures of knowledge management.

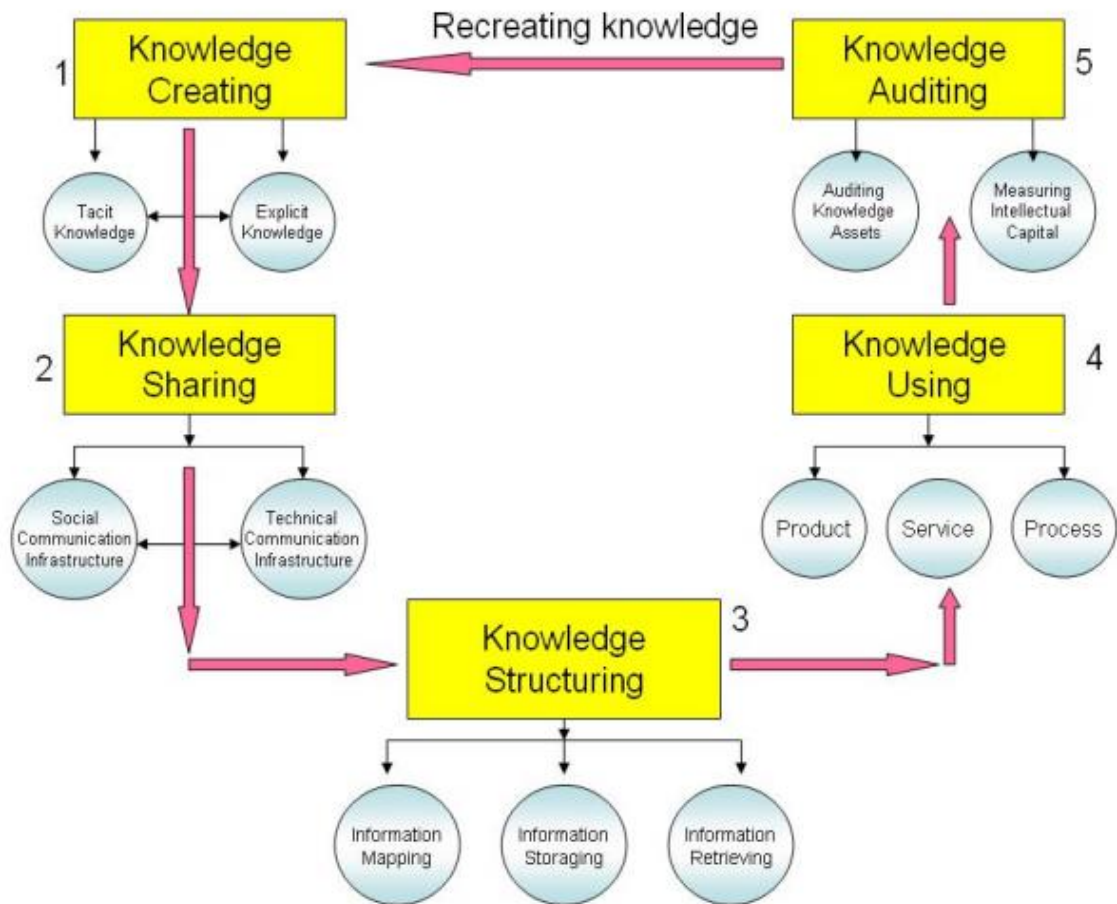


Figure 1: Knowledge life cycle model. Source: Sagsan (2006).

To sum up, it can be stated that knowledge management is an activity managing all the knowledge of an enterprise, which is effectively integrated with the competitive advantages of the firm; it also utilizes knowledge to foster innovativeness. Wig (1993) sums these arguments up by drawing out the following activities of knowledge management:

- Survey, develop, maintain and secure the intellectual and knowledge resources of the organization.

- Promote knowledge creation and innovation by all employees in the organization.
- Determine the knowledge and expertise required to perform work tasks, organize them make the knowledge available, “package” it (for example training courses, manuals or knowledge-based systems), and distribute it to the relevant points-of- use.
- Modify and restructure the enterprise organization to use knowledge most efficiently, take advantage of opportunities to exploit knowledge assets, minimize knowledge gaps and maximize the value-added knowledge content of products and services.
- Create and monitor future and long-term knowledge-based activities - in particularly new knowledge investments - based on the unique priorities and needs of different organization environments and clients.
- Safeguard organizational and competitive knowledge and control the use of knowledge to ascertain that only the best knowledge is used and that it is not given away to competitors.
- Provide knowledge management capabilities and knowledge architecture to support active knowledge management as part of the organization’s practices and culture.
- Measure performance of all knowledge assets and account for them to fulfil the organization’s mission and objectives.

As a conclusion, it can be stated that there are numerous subfields and approaches to knowledge and knowledge management. It is important to note that there is no comprehensive theory of knowledge management due to the numerous amount of contexts, in which knowledge can exist (Diedrich and Targama 2000).

The review can be summarized with the definition of knowledge by Polanyi (1966), who stated that knowledge is such a thing, which cannot be defined fully, since “we know more than we can tell”. The scope of this work is to investigate into the forms which make embedded knowledge completely, clearly and efficiently told. For this purpose, the actual forms of knowledge will be discussed in following parts

of the review. However it is also important to look into the knowledge-based view of the firm before reviewing the forms of knowledge in-depth.

2.2 Knowledge-based view of the firm

Organization, or a firm, is in the scope of this study. There is a lot of research on the topic of the nature of organizations, which tried to connect the performance of the firm with some key possessions of the firm. These are the strategic approaches, which allow the firms to differentiate themselves from competitors and thus acquire substantial competitive advantage.

These theories answer the following questions: “why firms exist” (Coase 1937) and “why firms differ” (Penrose 1959). There are quite a few theories of the firm, which try to answer these questions and make attempts to conceptualize, model, explain, and predict firm structures and behavior (Grant 1996). One of the first theories in this field is the transaction costs theory, which appeared in Coase (1937). Its main idea is that the organizations are established to minimize transaction costs. This leads to a critical question of whether the firm should outsource the economic activities to another organization, which is possibly better in them than the first organization, or the organization should conduct these economic activities using its own resources.

Another theory, which also had a great influence on the knowledge-based theory of the firm, is resource-based view of the firm, which was described by Penrose as early as 1959. It pictured the firm as a collection of various important resources, which companies use to foster their capabilities, and according to this view the company can excel only if it possesses rare, valuable and non-imitable resources (Barney 1992). Resources are valuable factors, which are owned or controlled by the firm and which are later converted into final products or services (Amit and Shoemaker 1993). In the post-industrial era it is obvious that the most important and valuable resources are intangible, since the production assets do not play the most important role anymore. The production is also knowledge-intense, since it required the application of many types of knowledge (Kogut and Zander 1992).

The core of the following discussion is the theory of dynamic capabilities, which received a lot of attention in the last decades (Prahalad and Hamel 1990; Porter 1990). This approach stems from earlier works on resources of the firm (e.g. Teece 1980), but it focuses on the dynamism of firm's resources due to ever-changing environment of post-industrial era. Some theorists, for instance Spender (1994) argued that in this era the possession of tangible and intangible resources is not enough to provide competitive advantage, since the real advantages can only be brought about with the help of organizational collective knowledge and coordination, which means that not only the resources, but their correct application may give the company an edge in competition.

According to the theory of dynamic capabilities, the mere configuration of the processes within an organization greatly affects operations, learning and firms' performance (Teece et al. 1997). According to the same seminal study, the main focus of the firm should be on the usage of competences and capabilities in a way, which can provide competitive advantage through accumulation of crucial resources.

Knowledge-based theory of the firm is derived from the theory of dynamic capabilities. It gives knowledge the priority among the firm's resources which can bring competitive advantages. Firms are regarded as the social communities, in which the existing knowledge is transformed into the services and products which become economically useful through the application of a set of high-order principles (Kogut, Zander 1992). Knowledge of the firm is accumulated and developed through learning and knowledge management practices, which lead to a competitive advantage. Grant's theory provides deep insight into the role of knowledge in the firm, and brings an understanding of firm's competences and aside of that, it deeply analyzes the influence of knowledge on the business' performance in the situation when the organization is constantly threatened by competition and external change (Grant 1996).

According to this theory, the knowledge-intensive companies are successful in competition because they have competitive advantages in the processes of knowledge creation, sharing, exploitation and protection which are better

performing than the ones offered in the market (Grant and Baden-Fuller 2004). This is exactly what makes the firms differ, the variation in management of organizational knowledge and in the practices of generation, integration and application of knowledge to business activities. The firms also differ due to the interfirm variations connected with leveraging of widely dispersed knowledge available to the firm (Tsoukas 1996). It is the fundamental problem of knowledge management to deal with knowledge which is dispersed, or, in other words, shared between the employees and not available to everyone in its totality (Hayek 1945). The firms which are superior at managing their knowledge get superior economic advantages. Efficient knowledge management may empower all actors within the organization with the knowledge that it already present there. Usually out of a knowledge mass of an organization only its insignificant parts are shared within the company with the rest of the employees in a clear and efficient way. The usage of these present capabilities might be crucial for the successful development of an organization.

It is important to note that firms in this theory act as social communities. They act as organisms with emergent and self-shaping properties, which are derived from the interactions of semi-autonomous units which possess the knowledge. Another important feature which has to be outlined is that firms gain competitive advantage by recombining their knowledge in new ways to create new capabilities (Kogut and Zander 1992). It is important, because knowledge is disseminated in various ways, and it possible that a mere recombination of knowledge may lead to new competitive advantages (Nahapiet and Ghoshal 1998). Another important feature of knowledge-based theory of the firm which has to be outlined is that according to this view knowledge is the resource which also has the greatest strategic priority (Winter 1987).

The essential elements of the knowledge-based view of the firm can be summarized as follows (Bloomquist and Kianto 2006):

- Knowledge is the most important resource and factor of production.

- Performance differences between firms exist because of differences in firms' stock of knowledge and capabilities in using and developing knowledge.
- Organizations exist to create, transfer, and transform knowledge into competitive advantages.
- Knowledge is related to humans.
- Individuals are intentional and intelligent agents.
- Humans are bounded by cognitive limitations; how much and what they can know have cognitive limits, and therefore they have to specialize.
- Especially in complex issues which cannot be understood by any single individual, there is a need for integration and coordination of knowledge.
- Cognition and action are related: knowledge is both acquired by and demonstrated in action.
- Knowledge is demonstrated in many forms and located on many levels: it is situated in the minds and bodies of individuals, embedded in organizational routines and processes, as well as codified in databases and books etc.
- Some knowledge can be externalized into explicit form, while some knowledge will always remain tacit.
- The form of knowledge influences how it can be leveraged and transferred.
- Shared tacit knowledge, demonstrated for example in capabilities, is the most important type of knowledge from the value creation point of view.
- Knowledge cannot be fully managed in the same sense as other types of resources; its management more resembles the creation of suitable contexts and cultivation.
- Knowledge is dynamic: it is continuously re-interpreted and modified, and related to learning and change.

In the knowledge-based view of the firm, knowledge management has an effect on the business outcomes, however this effect is not direct. It is important to note that knowledge management does not directly manipulate the knowledge outcomes, but instead it impacts processes of knowledge transfer in a domain, which in turn has a direct effect on the outcomes.

Figure 2 shows the three-tier framework by Firestone and McElroy (2005) which shows the way knowledge management activities make through three tiers of knowledge and business processing environments. This framework is a good example of how does knowledge management have an effect of business outcomes in the context of knowledge-based view of the firm.

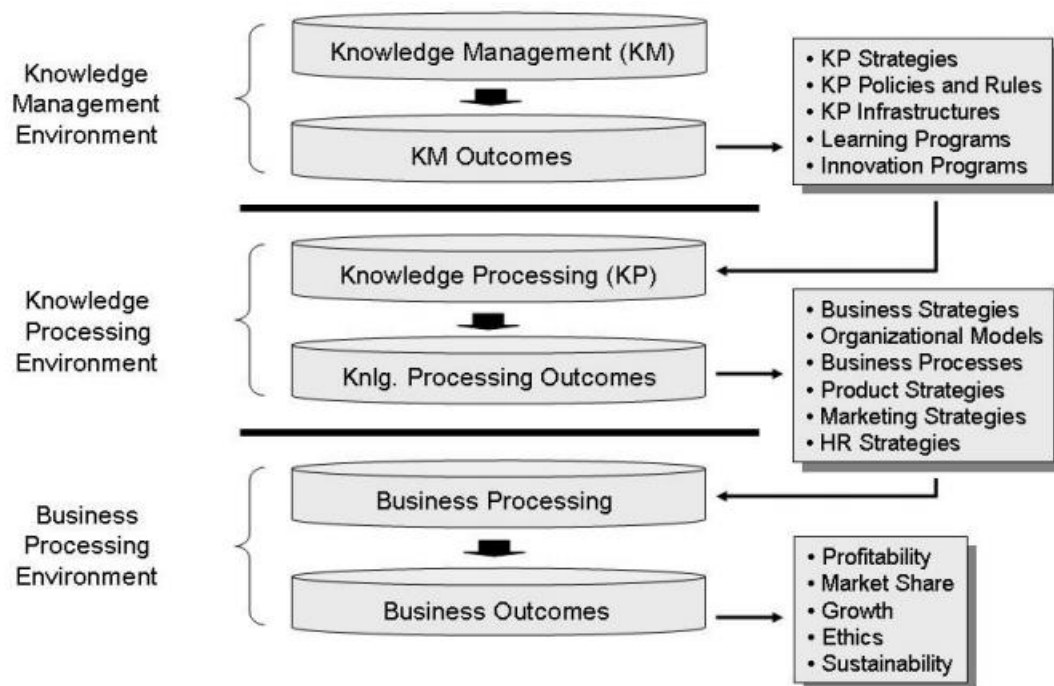


Figure 2. Three-tier framework. Source: Firestone and McElroy (2005).

According to this framework, first knowledge management has direct effect on the knowledge outcomes. Later these outcomes, which include knowledge processing strategies, learning and innovation programs, become the input to the knowledge processing environment, where they become business strategies, business processes, marketing strategies or other outputs. In the end these outputs play a role in the business processing environment where they influence profitability, market share, growth, ethics and sustainability. Generally this framework depicts the process of how does the knowledge management influence the business outcomes which reiterates the fact that knowledge management is a directly

related to management and that it significantly influence, if not defined, the performance of an enterprise.

The knowledge-based theory of the firm is of paramount importance for this study. It claims that knowledge is the main resource of the company, and firms which are superior at managing knowledge gain superior profits. It views the firms as specific organizations which enjoy superior performance due to their ability to efficiently manage their knowledge. This theory perfectly fits in the framework of this study. If knowledge is important for the firm, easy knowledge sharing processes bear the same importance, and the aim of this study is to find the form of knowledge which is the most efficient for knowledge sharing.

2.3 Knowledge sharing

As it has been stated before, knowledge is an extremely important resource for any company, which strives for a sustainable competitive advantage (Grant 1996; Davenport and Prusak 1998). However, in knowledge management practices companies should not only rely on the key employees, which possess the required specific knowledge, abilities and skills. The companies should both create and disseminate in-house knowledge and import knowledge from external sources and more effectively exploit knowledge resources which already exist in the organization (Spender and Grant 1996). However, in each case knowledge is transmitted from one subject to another. For instance, an example of intra-organizational knowledge dissemination would be the experts providing knowledge to the novices who need to get new knowledge on the subject (Hinds et al. 2001).

Such a transition of knowledge is called knowledge sharing. It is a fundamental method, through which the employees can put their efforts into knowledge application, innovation, and ultimately the competitive advantage of the organization; overall knowledge sharing is one of the key practices of knowledge management within an organization (Jackson et al. 2006; Issa and Haddad 2008). According to the definition of Wieviora, knowledge sharing is the interaction between individuals through the framework of knowledge sharing, institutions,

laws, norms ethics and behavior (Wieviora et al. 2010). When companies employ knowledge transfer practices, they benefit from all the amount of knowledge which is disseminated in the organization, which can improve the organization performance.

Some researches consider knowledge sharing to be the most important part of knowledge management within an organization (Aulawi 2009). This approach has emerged from both fields of technology transfer and innovation and from strategic management. Knowledge sharing within the firm in the form of knowledge exchange between individuals and between the groups of individuals allows for organizations to use and capitalize on knowledge-based resources (Davenport and Prusak 1998). Knowledge sharing can be conducted between individuals, in the interactions between individuals and knowledge containers, teams, inside the organization or between organizations. It has been explicitly shown in the researches that successful knowledge sharing positively affects reductions in production costs, new product development projects are completed faster, team performance is higher, and in case of successful knowledge sharing between the corporations, cooperation and trust between them are also enhanced (Collins and Smith 2006).

Knowledge sharing is important in project-based organizations to avoid unnecessary reinvention, since the knowledge which has been absorbed in one project, can be later reused in other projects (van Vuuren 2011). If such procedures are not done properly, the company might repeat the previous mistakes and utilize its potential in an inefficient way, which costs time and hampers profitability. It is required for the companies to foster the knowledge sharing within themselves, within its members and partners in order for the knowledge to be their strategic competitive advantage. The successful knowledge sharing also adds to accumulation of knowledge and creation of new knowledge. However, sometimes members of the organizations are not prone to share their knowledge (Isaa and Haddad 2008). The employees might also be reluctant to absorb new knowledge (Aulawi 2009). Companies should also foster the positive perception of knowledge sharing by its employees to make knowledge sharing easier and to allow for dissemination of knowledge to higher levels of

organizational hierarchy. Just like in the case of general acquisition and usage of knowledge management practices by companies, knowledge sharing has also been adopted by numerous enterprises to make collection, storage and distribution of knowledge easier.

There are five main contexts, which can affect successful knowledge sharing practices, they include the relationship between the source and the recipient, the form and location of knowledge, the recipient's learning predisposition, the knowledge sharing capability of the source, and the broad environment of the firm, which can be summed up into three knowledge-sharing types (Cummings 2003):

- First, analyses of the form and the location of the knowledge are important because each can affect the types of sharing processes that will be necessary as well as how challenging these processes might be.
- Second, the types of agreements, rules of engagement and managerial practices adopted by the parties are important to evaluate in that they can shape both the flows of resources and knowledge between the parties and the actions taken to overcome and accommodate significant relational differences between the parties.
- Third, the specific knowledge-sharing activities used are important in that they are the means through which the parties seek to facilitate knowledge sharing.

There are a plenty of variables, which affect knowledge sharing in in the firm. The literature on this topic is rich, and the papers successfully identify critical factors which have effect on the success of knowledge sharing. For instance, some of them include the type of knowledge which is shared, in terms of how tacit it is (Zander 1991), relations between the parties involved in knowledge sharing process (Hansen et al, 1999), the mindset and capabilities of the receiver of knowledge (Yeung et al. 1999), and the actual actions which are carried out to share knowledge (Davenport and Prusak 1998).

One of the main ones is knowledge internalization. It refers to the performance of the receiver of knowledge in the process of knowledge sharing. After the receiver absorbs knowledge, and if it is done correctly, the knowledge sharing has been

successful. The more the receivers of knowledge will show the discretion in this process, the more it is likely that they will add their ideas and unique knowledge in the process of knowledge internalization (Pierce et al. 2001). The success of knowledge transfer in this case is defined by the level, to which knowledge has been delivered to the recipient.

When the knowledge has been shared and the recipient internalized it, he can re-create and use it. For the future easier management of the internalized knowledge, the researchers advise for the organization, in which the knowledge is shared, to foster the atmosphere in which active learning perspective is pursued so the recipient of knowledge can actively reappropriate, adapt and reuse knowledge (Nonaka 1994).

Another important part of knowledge sharing is knowledge distance. It refers to the gap between the source of knowledge and recipient of knowledge in terms of the amount of knowledge they possess. Some studies have discovered that the smaller the gap, the easier it was to reach the level of the partner (Hamel 1991). On the other hand, the larger gap there is, the harder it will be for a recipient to absorb knowledge. It is worth to note that all individuals also have different absorptive capacities. There is a concept of so-called “relative absorptive capacity”, which shifts the concept from the personal to organizational level. The relation here means the knowledge of the recipient compared to the knowledge of the knowledge source. This notion again repeats the idea that the parties involved in knowledge exchange should try to align themselves to make knowledge transfer easier, and the greater alignment there is, which may include culture, technology, strategy, the easier it will be to share knowledge (Dinur et al. 1998). As noted in a different research, the knowledge can also be more tacit for some people than to others, which could make the knowledge sharing harder (Nelson and Winter 1982)

The knowledge sharing might be facilitated not only if the gap between the sender and the receiver is small, but also if there's a culture of learning within an enterprise (e.g. Davenport and Prusak, 1998). The culture of learning interacts with explicitness in a very peculiar way. According to researches on knowledge sharing within an organization, organizational learning goes through several

different stages. First, tacit knowledge, which is knowledge held in someone's mind, is accessed, then the knowledge which has been successfully accessed is translated and reconfigured in order to allow for the participants of knowledge sharing to make sense of it, then it is made explicit with the help of dialogues, and finally it is put into action in order to allow its conversion from explicit to tacit in the recipient (Nonaka 1994; Yeung et al. 1999).

There are also different models of knowledge transfer. According to Gilbert and Cordey-Hayes (1996), there are five stages of knowledge transfer, which include acquisition, communication, application and assimilation of knowledge. In the knowledge sharing process, all organizations have to go through all stages of this interactive and dynamic process.

However, in case if there is a strong culture of learning within an organization and it is economically suitable, it can be positive for knowledge sharing if the knowledge will not be fully explicit. It means that the recipients of knowledge can take part in articulation processes, which would help them to better absorb the knowledge and tailor it to their needs (Nonaka 1994). This means that early participation of the knowledge recipient in the process of knowledge creation might help him or her to absorb the knowledge. However, in a modern enterprise this could be unproductive due to division of labor and economies of scope, when individuals deal with their tasks only. An argument against it is that it is impossible to fully codify knowledge and hidden tacit elements will still persist in reality (Polanyi 1966). However, there is also another view on the matter, which states that delegation of responsibility, creativity, and the richness of knowledge which is shared, highly benefits the knowledge transfer processes (Davenport and Prusak 1998). For this work the more conservative approach is more favorable, since the scope of this study is on the explicit knowledge, while the tacit knowledge is outside of the scope of this study.

It is also extremely important to synchronize knowledge with the other crucial factors, for instance with the cultural beliefs of the recipient (Morosini et al. 1998). The personal characteristics of a receiver of knowledge are usually called "recipient context". The recipient context is extremely important and include such

factors as learning capacities (Dixon 2000), intent (Hamel 1991) and learning capability (Yeung et al. 1999).

However, not only the context of the recipient, but the context of the sender of information also plays an important role in knowledge sharing (Yeung et al. 1999). A source which is good at knowledge sharing activities might improve learning capabilities of the recipient, or help the recipient tackle his “learning disabilities”. The ways to achieve it include new organizational structures with more autonomy for the recipient, where he can use this option to become more flexible and adaptive in knowledge sharing (Weick 1979); the techniques to reduce the influence of “blind spots”, which block the recipient from taking decisions of others into account of his or her own decisions; in case organizational resources can limit the ability to develop knowledge sharing resources, the successful management of these resources or introduction of new ones by the recipient can also benefit the knowledge sharing (Levinthal and March 1993). This means that the source which is good at managing the knowledge can have a positive effect on the learning. Other important variables which affect the source of knowledge are willingness to share knowledge (Cabrera and Cabrera 2002), common identity with the recipient (Brown and Duguid 2000) and the awareness of the knowledge held by the sender (Borgatti and Cross 2003).

There are two other variables, which can also affect knowledge transfer success, credibility of the source with the recipient and the strategic intent of the source to complete the transfer (Cummings 2003). This credibility of the source implies that the recipient sees value in the process of knowledge being shared. In case the source is not credible, the knowledge may become less worthy to an individual, therefore the process of knowledge sharing will be hampered. However, this notion does not take into account the content of knowledge to be shared, only the credibility of the recipient, which is an issue of the model.

Another concept which has an impact on knowledge sharing is the existence of common identity (Davenport et al. 1998). It can foster knowledge sharing, since in case the individuals dwell in the same context, their knowledge absorption

capacity is improved. In the recent years it has become one of the most popular tools for enhancing of knowledge sharing (Christensen 2007).

However, even though the researchers have a plenty of features of knowledge sharing in their scope, the form of knowledge shared is also important. For instance, the form of the knowledge is considered to be ones of the most important factors in knowledge sharing in the study of knowledge sharing by the World Bank. This study of knowledge sharing outlines that successful knowledge sharing required the use of three interdependent types of knowledge-sharing activities, which include (Cummings 2003):

- Those focused on assessing the form and embeddedness of the knowledge.
- Those focused on establishing and managing an administrative structure through which differences and issues between the parties can be accommodated and reduced.
- Those focused on transferring the knowledge.

As it is expressed in the first type defined in the study, form of knowledge plays an important role in knowledge sharing. This factor is often neglected in studies as the one which defines the efficiency of knowledge sharing, but it is listed in pretty much any classification of factors which hinder or aid the knowledge sharing process.

Form of knowledge which is shared can also be included into the personal characteristics of the recipient, since some studies argue that various individuals perceive forms of knowledge in different ways. Such a type of featured in another classification by Wang and Noe (2010), who classify the areas of emphasis of knowledge which has to be taken into consideration:

- Organizational context
 - Organizational culture and climate
 - Management support
 - Rewards and incentives
 - Organizational structure

- Interpersonal and team characteristics
 - Team characteristics and processes
 - Diversity
 - Social networks
- Cultural characteristics
 - Individual characteristics
 - Motivational factors
 - Beliefs of knowledge ownership
 - Perceived benefits and costs
 - Interpersonal trust and justice
 - Individual attitudes

Even though the form of knowledge shared is considered to be important by the researchers, there is from little to no studies which access the influence of the form of knowledge shared on the knowledge sharing with managers in-depth. Often the form of the knowledge shared is studied indirectly, for instance in the case of “casual ambiguity” concept.

According to this concept, the transfer of knowledge is more difficult when there is ambiguity about factors, skills or elements of knowledge, which is in other words “casual ambiguity” (Lippman and Rumelt 1982). The greater this ambiguity is, the more difficult it is to identify common grounds for knowledge sharing. Therefore, casual ambiguity is one of the most important factors which affect knowledge transfer (Grant 1996). It has been shown that codified knowledge is easier to transfer and it exhibits less of casual ambiguity (Zander and Kogut 1995). On the other hand, knowledge which is articulated poorly, exhibits more casual ambiguity and therefore it is harder to share it (Hakanson and Nobel 1998).

To sum up, it can be stated that despite all theoretical approaches and features of knowledge sharing listed above, there is often a lack of consideration of how the knowledge form context and individual characteristics influence knowledge sharing within an organization (Carter and Scarbrough 2001). In order to approach this issue, the study goes on to investigate the forms, in which knowledge is shared

within an organization to later outline, how do they influence the context of knowledge sharing from the perspective of an individual manager.

2.4 Forms of knowledge, tacit and explicit knowledge

Knowledge within the organization takes different forms. The main division is between tacit and explicit knowledge. Nonaka (1994) viewed tacit and explicit knowledge as an iceberg. The peak of the iceberg is explicit knowledge, since only a minor share of knowledge exists in explicit form, while the biggest part is invisible knowledge, which is not expressed in any way, and it is difficult to visualize and transmit this knowledge (Nonaka and Teece 2001). Tacit knowledge allows for individual to understand matters and provide solutions for the problems without the need to explain the rationale for knowing, this kind of knowledge is personal and context-dependent. According to the seminal definition of Polanyi, tacit knowledge means knowing more than we can tell, or knowing how to do something without thinking about it (Polanyi 1966). Tacit knowledge is subjective, practical and personal, and example of it would be riding a bicycle. It can be stated that tacit knowledge is a part of person, it is deeply contextual (an example of it would be some area of expertise, in which a person is deeply knowledgeable) and it is hard to formalize it and communicate to others.

Tacit knowledge is extremely important for organizations, since without tacit knowledge explicit knowledge loses its meaning. Most of the tacit knowledge remains hidden and subconscious even for individuals themselves, it is impossible to explain fully what does an individual know, and it is even harder to express how the act of knowing happens. It often shows in skills and unconscious judgment, and it sometimes can be extremely difficult to separate tacit knowledge from the context of activity, in which this type of knowledge is employed.

There's also another definition in literature, which is implicit knowledge. It is extremely close to the notion of tacit knowledge, however there is a need to make a distinction between them (Nichols 2000). According to this study, implicit knowledge is the tacit knowledge of an individual which is observed by another

person (Nichols 2000). In other words, it is perception of the actions of a person, which articulate that he or she possesses some knowledge required to complete these actions. There is also a cognitive component of tacit knowledge, which refers to individual's mental models, beliefs, and other personal mental characteristics, aside of that, there's a technical component which is connected to the actual skills which can be applied by an individual in the specific context. (Popadiuk and Choo 2006).

Explicit knowledge is, on the contrary, academic or technical data, or other kind of knowledge which exists in a concrete form, for instance in the form of a manual, book or a copyright. It is well codified and shared through printed, electronic methods, education or other means, it is very common and can be used to solve the relevant problems (Smith 2001). This kind of knowledge can easily be disembodied and transmitted (Alavi and Leidner 1999), it can be object-based or rule-based.

The rule-based explicit knowledge can be divided into four types (Cyert and March 1963):

- Task performance rules for accomplishing organizational tasks and facilitating the transfer of learning.
- Record-keeping rules on what records and how such records should be maintained by the organization.
- Information handling rules that define the organization's communication system.
- Planning rules that guide the planning process and the allocation of resources among the activities of the organization.

The object-based explicit knowledge is a form which is related to a piece of existing knowledge, be for instance codified in words, numbers or formulas. Object-based knowledge is at the scope of this work.

Explicit and tacit knowledge differ in terms of easiness of transfer, appropriability and potential for aggregation and storage. They have different problems of knowledge transfer, while tacit knowledge is extremely hard to share since it is

incorporated in specific contexts; with explicit knowledge there is an opposite issue, this knowledge is easy to capture, which makes it a target for the competitors (Brown and Duguid 2001).

According to other definition, tacit knowledge is mainly based on the past experience while explicit knowledge refers to the rules and procedures that a company follows (Baets 2005). It is important to note that both of these types of knowledge are important parts of knowledge creation, sharing and storing. Conversion and creation of knowledge happen only on the basis of tacit knowledge (Baets 2005).

According to Nonaka and Takeuchi (1995), tacit knowledge is the kind of knowledge which is not articulated yet. However, this definition caused a lot of criticism. Tsoukas argued that tacit knowledge should not be reduced to something which exists only to be articulated, because tacit and explicit knowledge are not on the ends of some continuum, but they are actually two sides of the coin, and the most explicit knowledge cannot exist without the tacit knowledge. (Tsoukas 2002). It is also stated in the same work that tacit knowledge can exist only in action, and it is impossible to convert it, since after the conversion it immediately becomes explicit knowledge. This means that individual create knowledge not by mere conversion, but by continuous efforts.

This chapter can be summed up with the definition of Polanyi who argued that tacit knowledge is extremely hard to articulate, since individuals know more than they can explain (Polanyi 1966). Tacit knowledge is rooted in context and actions of individual, it is a continuous activity of knowing (Nonaka 1994). Explicit knowledge, which is well verbalized, can be shared and efficiently acquired by the recipient. The explicitness of the knowledge is extremely important for this study, as the study deals with the forms of explicit knowledge. In order to review the forms of knowledge shared in-depth, it is necessary to look into the forms of explicit knowledge.

2.5 Forms of explicit knowledge

As it has been reviewed, there are two main forms of knowledge, tacit and explicit knowledge. However, explicit knowledge is at the core of this work since it is the kind of knowledge which is used when knowledge is shared. It is now important to review explicit knowledge in-depth and outline the main forms of explicit knowledge.

The most typical forms of explicit knowledge include manuals and documents. These are long-established and most common forms of knowledge sharing within an organization. However, there is a plenty of visual tools which can also serve as forms of explicit knowledge, for instance concept maps, mind maps or argument maps.

The idea of knowledge visualization is quite old. Flow charts have been developed as early as in 1972 (Nassi and Shneiderman 1973), while pie charts have been in use even for a longer while. The application of formal tools of mapping began at least 30 years ago, and possibly even earlier. The visual tools became important so fast because for most people maps are much easier to follow than text or oral speech, however different kinds of maps might also differ (Mayer and Gallini 1990). There is some evidence from cognitive science that various visual tools and maps enhance knowledge sharing performance (Vekiri 2002).

First, this study reviews the types of knowledge visualization tools which come to knowledge management from the information science in the form of knowledge representation techniques. One of these forms is called a semantic net, which a visual method of knowledge depiction with the help of nodes in a directed graph (Quillian 1967). In this model the concepts are interconnected, and knowledge is shared through these connections. The perception of such a graph forms semantic structures, which therefore can be abstracted with the help of a computer language. However, the drawback of this model is that it can only model the knowledge which is well defined, which means that it best performs in areas such as medical prognoses (Genesereth and Nilsson 1987).

Another system which has been introduced to represent knowledge is the frame system by Minsky (1975), which again uses semantic networks to outline specifics of an entity. The frame in this approach consists of data lines, which are called slots and which have some specific parameters. Since each frame has some specific attributes, complicated structures of knowledge can be inferred through implication and inheritance of some semantic node attributes. Frames can be employed while representing knowledge, which highly depends on the context.

Another possible form of knowledge representation, which stems from the philosophical sciences, is ontology. Basically, ontology is an abstract conceptualization (Gruber 1993). According to Guarino and Giaretta (1995), ontology provides terms for representing all possible states of affairs, which are related to the given domain of knowledge. The issue about this method is that every abstract conceptualization means simplification, which means that some pieces of knowledge will still be lost. However, it can be fixed through the employment of contextual logic, which will make the knowledge more complex and introduce new assertions within the given context (McCarthy 1993). Aside of that, this drawback is diminished by the fact that after such a conceptualization knowledge becomes versatile, it is extremely easy to store, access, share and use it, and this can be done in an efficient, machine-readable form.

Aside of complex concepts which come from information science and artificial intelligence like ontologies, there are other, purely visual forms of explicit knowledge. Concept maps are such a form; it is a graphical form for organizing and representing knowledge. They include a set of concepts, which usually come in circles or boxes of some type, they also contain relationships between these concepts which are drawn with a line which connects those concepts. There are linking words written on those lines which specify the sort of relationship between those concepts. Concepts are defined as perceived regularities in events or objects, or records of events or objects, designated by a label. (Novak and Cañas 2006). Concepts with links between them form proposition, which provide meaningful statements, or, in other words, knowledge. There are studies which confirm that the use of concept maps enhances learning, for instance the students which used concept maps in their studies improved their knowledge transfer

performance, it is also outlined that students which favored concepts maps had better performance in every stage of knowledge transfer, acquisition, communication, application, acceptance and assimilation, and the more positive the perception is, the more the individuals are willing to use it (Tseng et al. 2012).

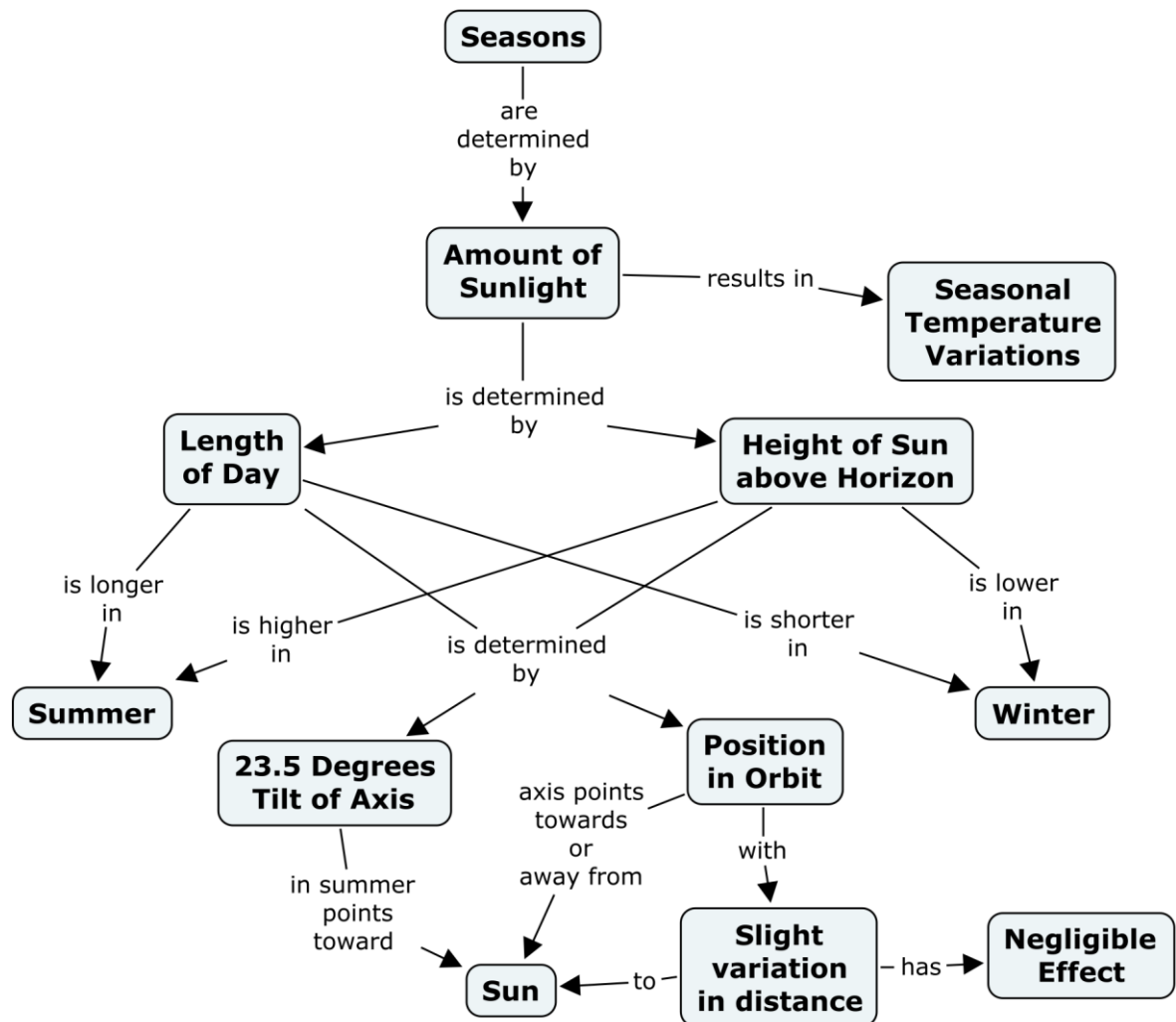


Figure 3. Concept map example. Source: Novak and Cañas (2006).

Figure 3 shows an example of a concept map. The most distinctive feature of this type of map is the clear visibility of all logical connections between the entities. The map consists of all notions from the piece of knowledge which are visibly connected to each other, which thus is supposed to facilitate knowledge sharing. However, the amount of concept displayed on an average concept map is big, which can thus make the comprehension harder.

Another issue of concept maps is that they may not fit the target groups, application situations or topic (Eppler 2006). The reasons which stand behind these issues are strict formal rules which have to be enforced while creating concept maps. Aside of that, the hierarchy of concept maps which go from broader to more narrow concepts are sometimes inadequate for representing, for instance, processes. The system of boxes and arrows makes it difficult to efficiently represent a great number of related items in an accessible format, which sometimes overwhelmed practitioners which were confronted with ready-made complex concept maps (Eppler 2006). Concept maps have in part been designed to counter the issues of simplicity of mind maps, but they, in turn lose in simplicity and creativity to mind maps.

Mind maps are another important tool of knowledge visualization (Buzan 1974). The formal definition of mind maps is a visual, non-linear form of representation of ideas and the relations between them (Biktimirov and Nilson 2006), but basically it is a network which consists of linked concepts of various levels of granularity.

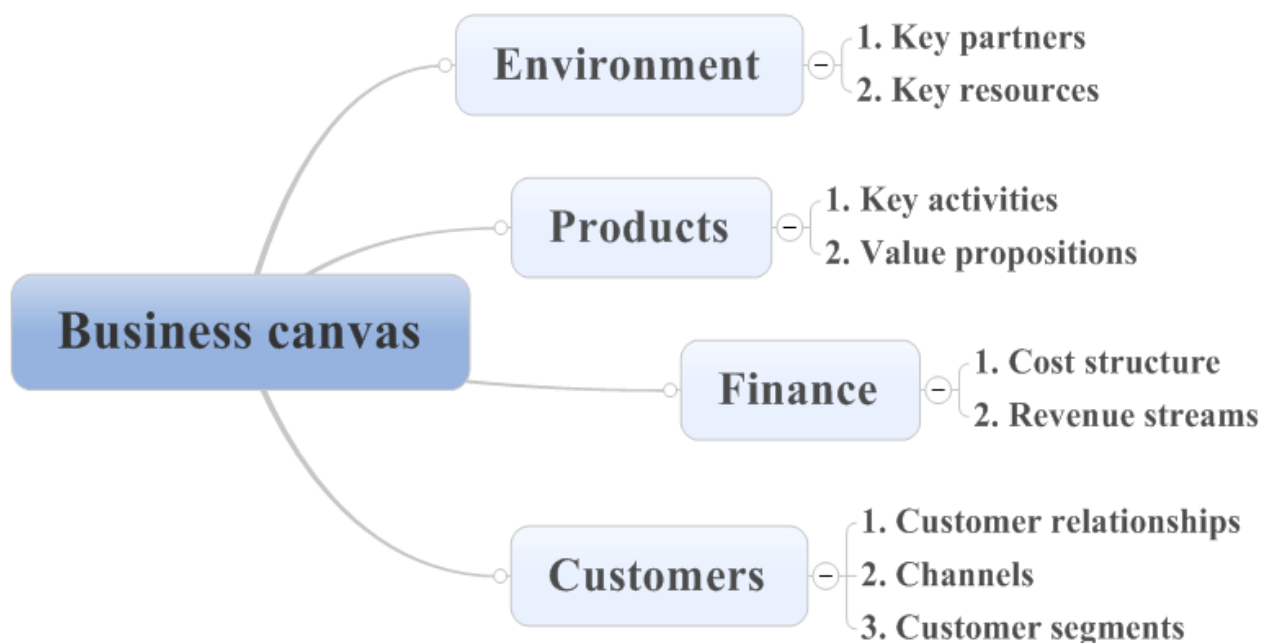


Figure 4. Mind map example. Adapted from Gavrilova et al. (2014).

Figure 4 presents an example of a mind map based on the Osterwalder's business canvas. The canvas has 9 parts, which include various business-related notions like key partners, cost structure or customer segments. These notions are all grouped by some intrinsic attribute into 4 main groups: environment, product, finance, customer. This sort of analytical grouping is the essence of mind maps. Mind maps concentrate on the groups which make up the whole with no regard to the connections between and within those groups. This is the opposite to concept maps, which on the contrary focus on the connections.

The advantage of this form is its free form and unconstrained structure, which means that the creative thinking is promoted, while brainstorming is also encouraged, but there is also such drawbacks as simple associations through which the concepts are linked. Mind maps can be inconsistent in terms of level of detail, some are missing the big picture and cannot deal with complex knowledge (Davies, 2011).

Another recent method of visualization is argument mapping, Argument mapping is concerned with explicating the inferential structure of arguments, while images and topics are the main feature of associative connections in mind maps, the concepts are the main relationships in concept maps, inferences between whole propositions are the key feature of argument maps (Davies 2011). Other methods of visualization include entity-relationship models, flow charts, Toulmin maps, IBIS argumentation maps, semantic networks, swim lane diagrams, clustering, UML diagrams, system dynamics, evocative knowledge maps, soft system modelling, or process event chains, Venn and Euler diagrams, Robert Horn's infomulas, radar charts, Zwicky's morphological boxes, Vee diagrams, knowledge cartographies, tree maps, 3D-cubes, S-curves, impact wheels, or graphic facilitation (Eppler 2006).

Out of all these forms of knowledge representation this study investigates the efficiency of three forms: text, concept maps and mind maps. Text has been chosen because it is one of the oldest and the most popular form of knowledge representation nowadays. Concept maps and mind maps have been chosen for comparison with text because these are two most popular visual forms of

knowledge representations with their own peculiarities. Concept maps are built around the connections between the concepts without any generalizations, while mind maps are on the contrary designed to describe abstract sets of generalizations. Thus, it is interesting to see how feasible it is to embed similar knowledge into these two conceptually different forms, how will the interviewees react to these forms, and how will they differ from text in knowledge sharing properties.

Another important feature which divides concept maps and mind maps from the text, aside of the visual side, is that the first two forms are structured. Unstructured knowledge usually means that knowledge is stored in various forms and formats, and there are complications when it is required to find some knowledge.

Structured knowledge differs significantly from unstructured knowledge as it allows for the whole new level of knowledge management. In the most simple meaning, which is used in this work, structured knowledge means the knowledge which has the key concepts and key connections mapped and available. When the logical connections and the essence of knowledge are mapped, it is possible to convert this knowledge to machine-readable format.

The bigger picture of knowledge structuring consists of three important components: mapping, storing and retrieving of information (Sagsan 2006). Mapping of information refers to determination of textual/graphical, audio/visual, tacit/explicit forms of knowledge and finding suitable information sources in organizations; information storing implies the placement of knowledge to repositories like databases, data ware house and information centers; knowledge retrieval is the most critical factor, in this stage knowledge is stored and retrieved via information retrieval systems such as surrogates, user interface, Boolean logic, Fuzzy logic, Vector query and Extended Boolean logic (Sagsan 2006).

Knowledge structuring categorizes data and information with the help of various tools to help retrieve this knowledge in an easy and an efficient way. Structured way is for instance represented by ontologies. The ontological approach encompasses the definition of knowledge as a set of ontological commitments, which prescribe how to view the world around us (Davis et al. 1993).

2.6 Ontologies

One of the biggest issues of knowledge sharing is the domain specificity of knowledge. An example of this is the issue of reusage of a knowledge-based program, which has objects, events, resources, constraints, plans which are defined in a hard or, in other words, heavily formalized way. According to Gruber, one of the main issues of knowledge management is the lack of reusability of knowledge, for instance the planner of a knowledge management system might face various knowledge databases, with some of them being generic and some of them domain-specific, and if one wished to use the planning system, one would need to adapt an existing knowledge base to a new application domain, or build one from scratch (Gruber 1993).

This is exactly the issue, which ontologies, as a comprehensive and modern way to represent knowledge, can deal with. Ontologies can solve the compatibility issues in rapidly changing systems with the environment of distributed knowledge, and to generally improve knowledge management practices within the organizations. Aside of that, ontologies can make any information searches knowledge-based, and not simply data match-based. In the framework of this approach, explicit knowledge of the knowledge management system is annotated in a form which allows for machine-processable handling of metadata based on the foundation of ontology (Davies et al. 2005). Usage of ontologies makes it possible for knowledge management system to unite all actors of the domain into a single hive-like system, where through the means of common language knowledge can be stored and requested in an efficient way.

Thus, the relevance of ontologies to this study is connected to the structured forms of knowledge. Text is an unstructured form, therefore it is impossible to fit in the ontology-like framework to create a comprehensive database of company's knowledge. However, structured visual forms can be used as a basis for ontology. Therefore, if the visualized forms with structured knowledge are better for knowledge sharing and easier for individual's comprehension than text, they can also contribute to the ontological knowledge management system of an enterprise.

The main feature of the ontology is that it scopes out knowledge management very broadly as any process of generating new knowledge, acquiring valuable knowledge from outside sources, selecting needed knowledge from internal sources, assimilating knowledge to alter the state of internal knowledge resources, embedding knowledge into organizational outputs, and leading, coordinating, controlling and measuring all these five kinds of activities (Igoshe 2014).

It is done through an exposure of a set of abstract concepts within a domain and an exposure of their properties and interrelationships within them. Basically, it is a world which consists of a set of types, properties and relationships. Ontologies are often viewed as a way to increase and enhance communication either between humans, or between humans and computers. By offering a shared conceptualization of the world and interrelationship between entities, ontology will facilitate the global understanding due to an effective description of heterogeneous content. Ontologies are generally organized as hierarchical structures, which are designed to provide knowledge in a formal and reusable way; they might also be represented in logical formalisms, such as Web Ontology Language (OWL) (Dean et al. 2004). Ontologies operate at the semantic level, enabling for interoperability among disparate systems, and specifying interfaces to independent, knowledge-based services (Gruber 2007).

Rapid development of ontologies began in the beginning of the 1990s, and in part it was interconnected with the rise of the World Wide Web. Since then a massive amount of literature on ontologies has been accumulated. The whole amount can be divided into three main parts, first, the seminal works of the most renowned ontology researchers, which basically created the whole theoretical framework of ontological engineering; second, literature devoted to the technical background of ontologies, including various approaches to handling of ontologies and languages of ontological programming; third, literature on the application of ontologies in various fields and the assessment of the outcomes of the usage of ontologies for better knowledge sharing.

First the modern concept of ontologies as the mean of knowledge transmission arose in the field of artificial intelligence. It has been developed in order to allow for

the knowledge sharing among artificial intelligence systems. The term ontology itself first appeared in 1967, in a work on data modelling (Smith 2003). Later, in early 1990s, ontologies acquired theoretical foundations in the works of renowned ontology researchers like Gruber (1993) Guarino (1998), Gomez-Perez (2004), Mizoguchi and Ikeda (1996).

Ontology has acquired a following definition: ontology is an explicit specification of a conceptualization while a conceptualization is an abstract, simplified view of the world that we wish to represent for some purpose (Gruber 1993). According to the same seminal study, ontology should contain classes which represent the concepts, relations which represent the connections between the concept and the domain, functions, formal axioms and instances. A classic formal definition of ontology is the specification of a conceptualization, while a conceptualization is an abstract, simplified view of the world that we wish to represent for some purpose (Gruber 1993).

Aside of that, ontology can also be defined as a particular system of categories accounting for a certain vision of the world (Guarino 1998). According to the definition of ontology, Studer et al. (1998) draws the following conclusions: ontology is a machine-readable specification of a conceptualization in which the type of concepts used and the constraints on their use are explicitly defined, and ontology should only capture consensual knowledge accepted by large group of people rather than just some individuals.

The crucial part of ontology is the tool of common vocabulary which is used to create a common language for knowledge sharing. The common vocabulary of the ontologies means that the knowledge will have a solid structure, to which all the users have agreed to. It can transform heterogeneous data into formats which will allow for easy knowledge transmission and knowledge reproduction. This so-called ontological commitment allows to enhance knowledge management not only in the AI sphere, but also in domains like biology or organizational engineering. Works of Gruber (1993), Guarino (1998), Gomez-Perez (2004) provide both technical and common-sense background for an ontological framework of an organization, and are of critical importance for the study.

These authors developed various classifications of ontologies. Guarino (1998) divided ontologies by their purpose:

1. Top-level ontologies describe very general concepts like space, time, matter, object, event, action, etc., which are independent of a particular problem or domain: it seems therefore reasonable, at least in theory, to have unified top-level ontologies for large communities of users.
2. Domain ontologies and task ontologies describe, respectively, the vocabulary related to a generic domain (like medicine, or automobiles) or a generic task or activity (like diagnosing or selling), by specializing the terms introduced in the top-level of ontology. Organizations mostly employ domain ontologies for easier knowledge sharing.
3. Application ontologies describe concepts depending both on a particular domain and task, which are often specializations of both the related ontologies. These concepts often correspond to roles played by domain entities while performing a certain activity, like replaceable unit or space component.

Mizoguchi and Ikeda (1996) have two classifications of ontologies, for general ontologies, and for the domain ontologies. General ontologies include three kinds:

1. Content ontologies for reusing knowledge.
2. Communication (tell and ask) ontology for sharing knowledge.
3. Indexing ontology for case retrieval.

Domain ontologies, which are the systems of vocabulary for describing the domain, are usually divided into the three categories as well (Mizoguchi and Ikeda 1996):

1. Object ontology related to objects under consideration in the task, which covers the structure and components of the object.
2. Activity ontology related to activities taking place in the domain. Verbs play important role in this ontology, however, they are different from those in task ontology. The subjects of the former verbs are objects, components or

humans involved in the activities of interest, while those of the latter are domain experts.

3. Field ontology related to theories and principles which govern the domain. This ontology contains primitive concepts appearing in the theories and relations and formulas constituting the theories and principles.

Typology of Guarino (1997) is the most simple and comprehensive one. He divides ontologies in two major groups. In the first one he ranges the ontologies according to the level of detalization. In the other group the ontologies are ranged on the basis on their purpose, and they include top-level, domain, task and application-based ontologies. Top-level ontology usually describes the most comprehensive concepts like events and actions, which are then specified. Domain ontologies are used to describe the contents of a given domain, actors and relationships within this domain, including elementary principles which govern the given domain (Gomez-Perez and Benjamins 1999). Task ontology is designed to solve a specific task, and it usually borrows concepts outlined by ontologies of a higher level.

Another classification is delivered by Gomez-Perez et al. (2004), which divides ontologies into lightweight and heavyweight ontologies. Lightweight ontologies include simple concepts, relationships and properties; it does not require more sophisticated formal languages. Heavyweight ontologies are based on semantics and require complicated languages to impose all of the restrictions in the domain. In organizational ontological engineering the latter is more common, since organizations use complex knowledge management solutions, which already incorporate the required foundation of heavily formalized ontological languages.

One of the primary applications of ontologies, which is a significant part of the literature available, is the Semantic Web, which is based on the principles of ontological engineering. The structure of the contents of the World Wide Web does not allow for the smart search and acquisition of knowledge, since HTML-based web content is solely designed for formatting and displaying information on the web and computers have no way of understanding and processing the semantics of these web contents (Antoniou and Harmelen 2004). As a result, during a web

search the words are the input, and the output is a simple match of the words, however it is not the actual knowledge, instead of it the results may be chaotic. To make the Internet smarter, we can also use the ontologies, so the web content would be represented in a structural form (Berners-Lee et al. 2001). The very same techniques of ontological engineering are used here – the population of a domain agrees to use a clear pre-defined vocabulary, and then the knowledge is fitted into the framework for automated search. The issue might arise not only from the poorly structured data, but also from the difference of sources themselves, ontologies can also be used to overcome this issue (Antoniou and Harmelen 2004).

Ontologies has been applied in various spheres of knowledge management, in e-commerce, enterprise integration and cloud computing. There are other numerous other fields of application of ontological concepts, for instance standardization of product knowledge, medicine, mechanical engineering, geographic, legal, and biological information science (Guarino 1998), however it is necessary to look into the organizational ontologies since they correlate with the scope of this study.

The term organizational ontologies is usually used in two ways. First way to understand organizational ontologies is to view them as an abstract conceptualualization of the organization itself, of its actors and relationships within it. Second way is organizational ontologies as ontologies which are used within the organization for knowledge management practices of knowledge sharing facilitation.

First case is ontological analysis of an organization itself. It is a dynamic analysis, since it is focused on the actions which take place between various agents inside the organization. It is a part of a generic analysis of the company, and it is ought to answer the following questions: “What kind of relation does it hold between an organization and its members?”, “What is necessary for a certain agent in order for him/her to be a member of an organization?”, “Which is the relation holding between the roles in an organization and its normative layer?” (Botazzi and Ferrario 2009). These questions, put in the context of the functioning of the

organization, define organizational efficiency, which exposes the importance of the topic of organizational ontologies for business research.

According to a seminal work by Fox and Gruniger (1997), organization ontologies are:

- Process and activities: Including the representation of status and time, this area has received the greatest attention in the fields of artificial intelligence, knowledge representation and also from the planning communities.
- Resources and inventory: General representation of resources, inventory, locations etc.
- Organization structure: Representation of positions, roles, departments, processes, goals, constraints, etc.
- Product structure and requirements.
- Quality: Basic representations of quality in support of ISO9000, QFD, etc.
- Cost: Representation of resource costs, activity costs, activity-based costing, etc.

Some of the contemporary ontologies are developed exclusively for organizations, like the organizational ontology of Epimorphics Ltd. or IntelLEO organizational ontology, there is also a SHOE organization ontology by University of Maryland. All of these ontologies can be applied in knowledge management in an international or a Russian company.

The main works on the usage of ontologies in organizations were created by (Bernus et al. 1996; Fox 1992; Schlenoff 1996; Uschold et al. 1998). However, overall there are not so many works on the ontology of organizations (Botazzi and Ferrario 2009).

Second case is not the ontologies of, but the ontologies within the organization. Usually knowledge workers develop ontologies for organizations which are required by knowledge workers themselves. However collaboration between knowledge engineers and knowledge workers is required to ensure the active and decisive inputs of all groups into the process of developing an organizational ontology (Stojanovich et al. 2002).

The importance of ontologies is such that that there have been developed special ontological knowledge management systems to easily store and share knowledge of organizations (Alavi and Leidner 2001). To make it possible for machines to operate with knowledge, it has to be encoded into machine form and it has to be transformed from the distributed knowledge environment into a centralized knowledge database, to form a comprehensive and integrated framework. It can also improve the quality, content, value of knowledge, and provide easier access of both individual and group knowledge within an organization (Mentzas et al. 2001). Aside of that, easier ways of knowledge management foster the creation of new knowledge.

An example of an organizational ontology which can be used for knowledge management within organizational with the use of structured knowledge is suggested in Benjamins et al. (1998). This paper proposes another ontological system of knowledge management which makes it possible to store the whole amount of knowledge of the company in a computerized system (Figure 5). The paper proposes a search engine within a company, which has all the company's knowledge in a structured form. The knowledge is contained in a database, which is created by a joint effort of knowledge users and IT experts. The interface is provided by the annotated webpages which are also used in a webcrawler. Whenever a user has to acquire some knowledge he performs a query and receives an answer from the results of an intelligent webcrawler.

Aside of that, such an ontological system makes it possible to derive knowledge from the company's knowledge base which is not stated explicitly. For instance, if there is a rule that only senior managers can lead projects and some certain employee is a project leader, such a system is able to deduce that said individual is a project leader (Benjamins et al. 1998).

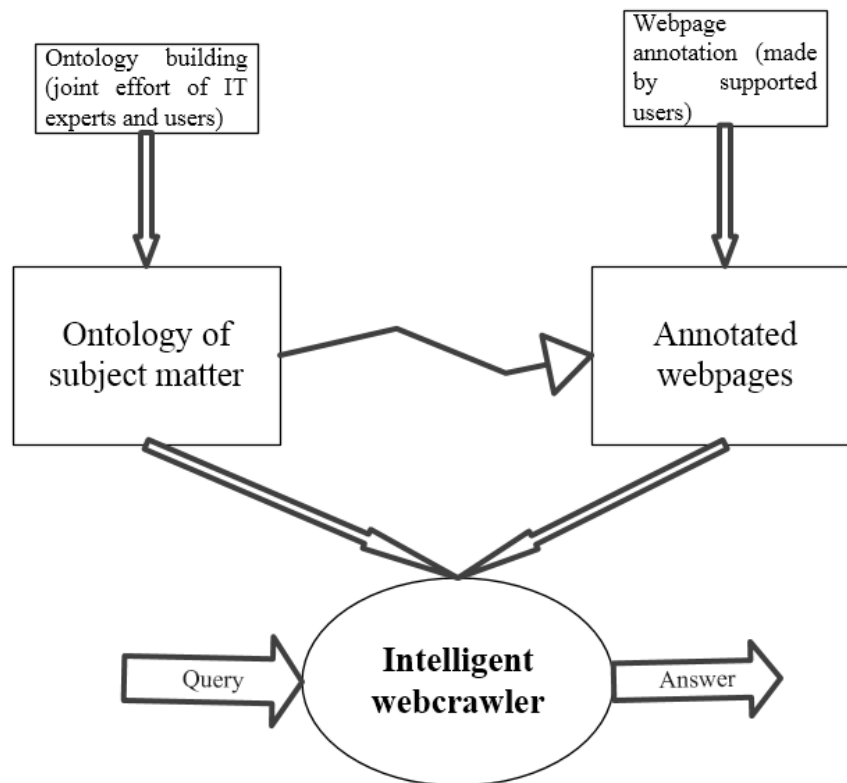


Figure 5. An example of an ontological knowledge management system. Adapted from Benjamins et al. (1998).

This analysis of the ontological systems of knowledge management is extremely important in the context of difference between structured visual forms of knowledge like concept maps, and, to a lesser extent mind maps, and the textual unstructured form. If the textual forms are used, it is impossible to shift to the more efficient ontological forms of knowledge management. However if the structured forms of knowledge representation like concept maps are used in the daily knowledge management activities, it is possible for an enterprise to switch to ontological systems over time.

2.7 Research gap

Even though there is an extensive amount of literature on knowledge, knowledge management, knowledge sharing, forms of knowledge and explicit knowledge in

particular, there are very few works which actually access the efficiency of forms of explicit knowledge in knowledge sharing.

Studies on knowledge sharing within the firm mostly focus on other concepts of knowledge sharing, for instance Alrawi and Alrawi (2011) studied the managerial perception of knowledge sharing. Even though the managerial perception is also a part of this work, this work is mostly focused on the actual forms of knowledge in the knowledge sharing process. The study by Amayah and Nelson (2010) also studies the similar topic, but its scope is the practices of knowledge sharing within the firm, which include the reasons to share knowledge, timing of knowledge sharing, however the visual forms are out of scope of this study. A paper by Christensen (2007) explores forms of knowledge sharing in a Danish production facility, but it studies not the actual forms of visual knowledge, but the forms of tacit knowledge, which include professional knowledge, coordinating knowledge, object-based knowledge and know-who (Christensen 2007). One of the closest studies to the topic of this thesis has been recently performed by Bresciani et al. (2014), however even though that study also researched the effect of the model of knowledge representation on learning, it studied the student's attitude, while this thesis studies the effect of the form on the efficiency of knowledge sharing process. Other similar works include (Tseng et al. 2012), however none of them directly access the efficiency of the form of shared knowledge.

Among the most relevant studies is the study by Gavrilova et al. (2014) which investigated into the question of how mind mapping of business canvas enhances the knowledge perception, however the sample in that study was rather small (22 respondents).

Taking in account that the form of knowledge shared is considered to be important (e.g. Cummings 2003, Wang and Noe 2010) it is necessary to research the issue of comprehension of knowledge forms by managers in order to close the respective research gap.

3 METHODOLOGY AND RESEARCH DESIGN

3.1 Research methodology

The study follows the experimental quantitative design. The study is experimental because the experimental interviews are conducted with a specific array of questions, which allow to not only extract a specific amount of knowledge from an individual, but measure his reaction and his response to the information provided to him or to her. The study is quantitative because the output of the interviews is converted into the quantitative form, which allows to measure whether the difference between various measured variables is statistically significant.

This study measures the effect of different forms of knowledge on the efficiency of knowledge sharing. In other words, the task is to measure how well do individuals extract knowledge from the given forms. The forms of knowledge which are reviewed in this study are text, mind maps and concept maps. The parameters which are measured in this study are time to extract knowledge and the quality of knowledge sharing measured with the help of a modified Likkert scale.

There were numerous studies and articles in favor of visualization (e.g. Eppler 2006, Davies 2011, Gavrilova et al. 2014), therefore, in order to test the efficiency of visualized forms of knowledge in knowledge sharing the following hypotheses are proposed:

1. H1: The difference in time of knowledge sharing through text, mind maps and concept maps is statistically significant.
2. H2: The difference in quality of knowledge sharing through text, mind maps and concept maps is statistically significant.

In order to further assess the efficiency of the forms of visualization, additional hypotheses are proposed:

1. H3: The difference in time of knowledge sharing through visualizations is statistically significant.

2. H4: The difference in quality of knowledge sharing through visualizations is statistically significant.

3.2 Sample

For any research it is impracticable to collect data from the entire population, it is more efficient to select a sample (Saunders et al. 2009) The population which is being investigated in this study consists of managers who have to deal with knowledge on the daily basis. Industry doesn't play a role here, because the study doesn't investigate the industry-specific knowledge but the knowledge form which can contain any kind of knowledge. However, knowledge perception might change with age and experience of an individual, therefore, since the sample used in this study consists of business school students who are a proxy for managers and who are mostly 22-24 years old, the population under consideration has to be limited to younger managers.

There are two main types of sampling techniques, probability sampling and non-probability sampling. For non-probability samples, the probability of each case being selected from the total population is not known and it is impossible to answer research questions or to address objectives that require making of statistical inferences about the characteristics of the population, however it may still be possible to generalize from non-probability samples about the population, but not on statistical grounds (Saunders et al. 2009)

With probability samples the chance, or probability, of each case being selected from the population is known and is usually equal for all cases, which means that it is possible to answer research questions and to achieve objectives that require to estimate statistically the characteristics of the population from the sample, consequently, probability sampling is often associated with survey and experimental research strategies (Saunders et al. 2009).

The study follows the simple random sampling technique. The sample consists of 76 students from Graduate School of Management (Russia) and Lappeenranta University of Technology (Finland).

This study investigates into the issue of knowledge visualization and attempts to assess the performance of various forms of knowledge when it comes to perception of these forms by the managers. Second year master degree business school students have all the required managerial skills and capabilities, aside of that they will most likely be employed and thus will become actual employed managers the following months after graduation. Therefore, it is possible to access the perception during experimental interviews with business school students who form the sample.

The main limitation of this approach is the age and experience of the students. The interviewed students are 22-24 years of age, and most of them have limited work experience. Despite the knowledge sharing properties might possibly remain unchanged with age, in order to avoid possible bias the population under investigation should be limited to managers of 20-30 years of age.

3.3 Questionnaire

The questionnaires are reliable, since each person (respondent) is asked to respond to the same set of questions, it thus provides an efficient way of collecting responses from a large sample prior to quantitative analysis. (Saunders et al. 2009) However, it is required to ensure that it will collect the precise data that is required to answer the research question(s) and achieve research objectives. (Saunders et al. 2009).

The questionnaire designed for this study makes it possible to outline the most efficient forms of knowledge for knowledge representation. It features three different samples of text of the same size (around 90 words) from a scientific article on management, which doesn't have any words or concept which might be impossible to understand for an individual with a managerial background. Moreover, the samples of text are chosen in such way so the amount of knowledge would be the same in each one of them, in other words, it was made sure that one sample is not overloaded with facts while another one is a more abstract discussion of some issue.

These are the three pieces of text which are used for the forms of knowledge representation (Hamel and Prahalad 1985):

1. Perhaps the most difficult problem a company faces in global competition is how to allocate resources. Typically, large companies allocate capital to strategic business units (SBUs). In that view, an SBU is a self-contained entity encompassing product development, manufacturing, marketing, and technology. Companies as diverse as General Electric, 3M, and Hewlett-Packard embrace the concept. They point to clear channels of management accountability, visibility of business results, and innovation as the main benefits of SBU management. But an SBU does not provide an appropriate frame of reference to deal with the new competitive milieu.
2. European governments frustrated the attempts of companies to use offshore sources or to rationalize production through plant closings, layoffs, and capacity reassignments. European TV makers turned to political solutions to solve competitive difficulties. In theory, the resulting protectionism gave them breathing space as they sought to redress the cost imbalance with Japanese producers. Because they were still confined to marginal, plant-level improvements, however, their cost and quality gap continued to widen. Protectionism reduced the incentive to invest in cost competitiveness; at the same time, the Japanese producers were merging with Europe's smaller manufacturers.
3. Just as they had not been content to remain private-label suppliers in the United States, Japanese companies were not content to remain component suppliers in Europe. They wanted to establish their own brand positions. Sony, Matsushita, and Mitsubishi set up local manufacturing operations in the United Kingdom. When, in response, the British began to fear a Japanese takeover of the local industry, Toshiba and Hitachi simply found U.K. partners. In moving assembly from the Far East to Europe, Japanese manufacturers incurred cost and quality penalties. Yet they regarded such penalties as an acceptable price for establishing strong European distribution and brand positions.

Out of these three samples one sample (number 3) remains as a text sample, while two others are visualized. The visualization is performed in a way which doesn't give the visualizations an advantage over the text, since the amount of

knowledge is kept the same and nothing is removed aside of a couple of words which are useless for the visualization.

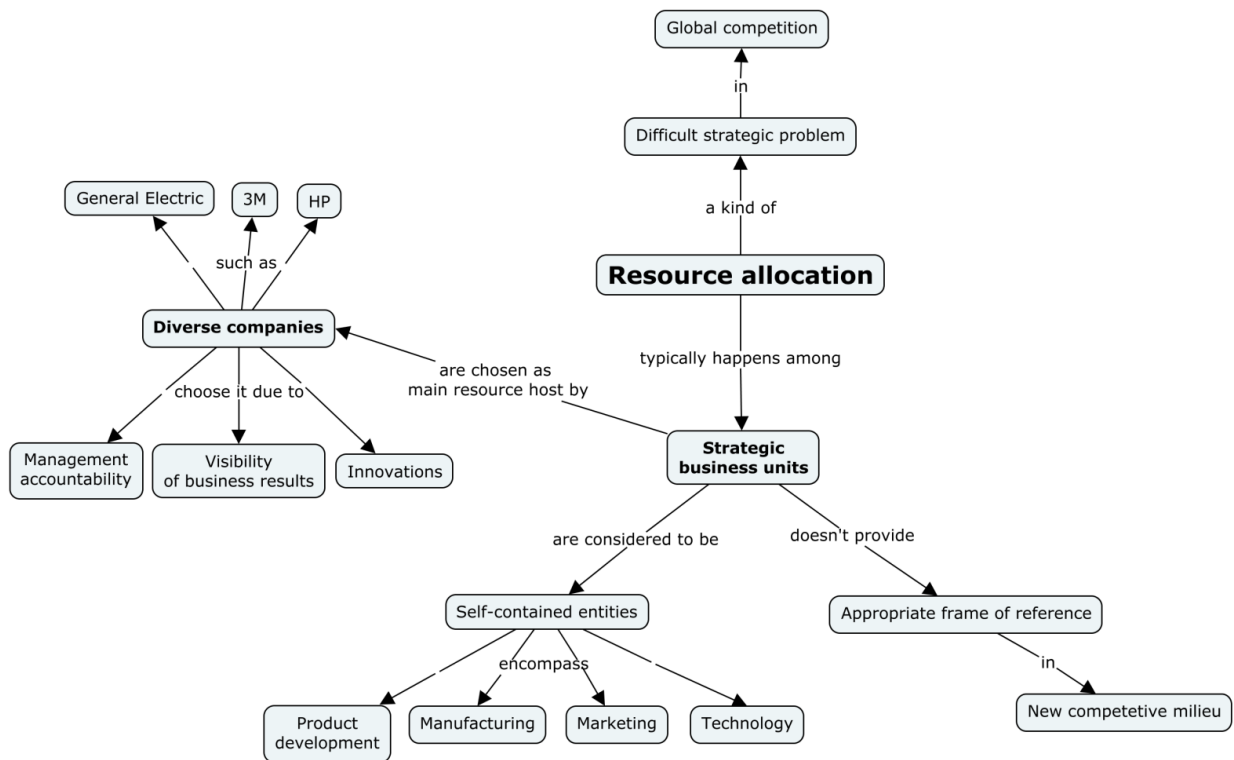


Figure 6. Concept map as an experimental form of knowledge representation.

Figure 6 presents the concept map based on the text sample number 1. All the concepts presented in the text like companies or SBUs are connected to each other with a set of various connections, which maps the available knowledge and structures it.

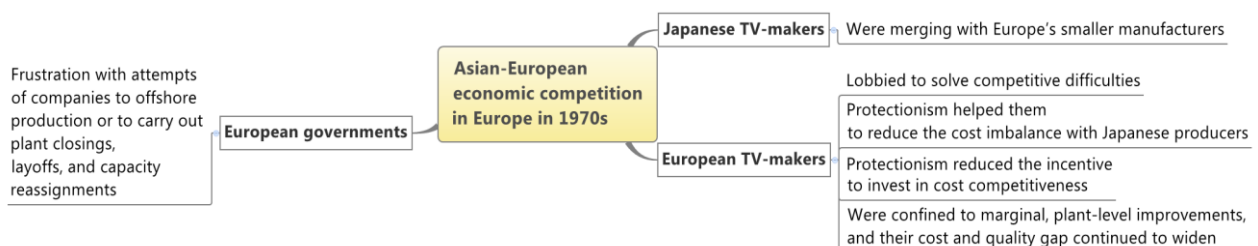


Figure 7. Mind map as an experimental form of knowledge representation.

Figure 7 shows the mind map which is based on the text sample number 2. This map is based on different principles compared to the concept map. While the

concept map is centered around various connections, mind map groups notions in broader categories and thus maps the knowledge. It is important to note that since the principles of concept maps and mind maps are different, it sometimes is more difficult to fit a certain piece of knowledge in either mind maps or concept maps.

The forms in the interview are followed by time measurement and three questions on each respective form. This is the experimental part, because the quality of comprehension is questioned. The questions are also designed in a way which gives them the equal amount of knowledge to address in order to avoid the biases.

3.4 Interview

In this study, interview is an experiment; therefore it is necessary to describe the structure of the interview.

First, the instructions are delivered. The participants are instructed to read the text or visualization and spend as much time to it as they consider being enough to understand everything written there to afterwards answer some questions about the knowledge presented in the form. It is important to note that there might be bias of lack of common understanding between the participants, different people might try to memorize everything and some can just browse through the knowledge representation form. This bias is avoided by the fact that each participant is given three different forms and his bias will be equal between his answers, therefore, the goal measurement of the study is unbiased.

Second, once the participant starts reading the form, I start the timer and measure how long did it take the individual to read the form. It is also important to note that the sequence of the forms is shuffled in each interview to avoid a bias where the first form in the interview can be harder for the interviewed person while the following ones are easier.

Third, after the participant has finished reading, the questions are asked and the results are recorded. As it was already noted, the questions for each form address the same amount of knowledge in order to avoid the bias.

3.5 Quantitative study

There are two variables which were chosen to establish the effect of the form of knowledge representation on the efficiency of knowledge sharing: time and quality. Time is the crucial factor, since less time means less information overload, which thus increases the manager's efficiency (Hemp 2009). The quality of knowledge sharing is important due to several reasons, for instance due the effect of knowledge internalization. The better the receivers of knowledge absorb it, the more it is likely that they will add their ideas and unique knowledge in the process of knowledge internalization (Pierce et al. 2001).

The results of the experiments are encoded in the quantitative format. The time is already in quantitative form; however the answers should be encoded. This study uses the modified Likkert scale and the answers are rated on the scale from 1 to 5:

- 1 – The answer is completely wrong/absent.
- 2 – The answer is mostly wrong.
- 3 – The answer is partly correct and partly wrong.
- 4 – The answer is mostly correct.
- 5 – The answer is absolutely correct.

The part below is an example of the grading scale. The following questions are the questions on the concept map as the knowledge representation form:

- What is the issue of resource allocation within strategic business units?

5 – The answer is absolutely correct. This means that the answer is as precise as it was in the scheme. In this case, it is “Strategic business unit resource allocation doesn’t provide an appropriate form of reference in the new competitive milieu”.

4 – The answer is mostly correct. To receive a lower mark of 4, the answer should have its two primary parts present (appropriate form of reference, competitive milieu), however they might be formulated in other words with a certain degree of abstraction. For instance, “Strategic business unit resource allocation is no longer valid to analyze the new competitive environment”.

3 – The answer is partly correct and partly wrong. In this case, one of the main parts of the answer is missing. The example is “Strategic business unit resource allocation does not provide an appropriate frame of reference”.

2 – The answer is mostly wrong. Both parts are generally missing, however some generic idea is voiced which is related to the text. For instance, “Strategic business unit resource allocation is an outdated concept”.

1 – The answer is completely wrong/absent. No answer given or the answer is random.

- Which companies use the concept of strategic business unit resource allocation?

5 – The answer is absolutely correct. This means that the answer is as precise as it was in the scheme. In this case, all three companies are named as General Electric, 3M, HP.

4 – The answer is mostly correct. To receive a lower mark of 4, the three companies should be named, however there might be mistakes in the companies’ names. For instance, General Electric might be remembered only partly and confused with General Motors, so an example of such an answer would be “General Motors, 3M, HP”.

3 – The answer is partly correct and partly wrong. In this case, one of the companies is missing or named incorrectly.

2 – The answer is mostly wrong. Two companies are missing or incorrect.

1 – The answer is completely wrong/absent. No answer given or the answer is random.

3.6 Statistics

First, the three chosen forms of knowledge representation (mind maps, concept maps and text) are presented during interviews to estimate whether they differ in terms of time it takes to extract knowledge (measured in seconds) and the quality of knowledge sharing measured by the answers mapped on a Likkert scale.

The data set is taken to SPSS where ANOVA one-way tests are run using “time” and “answer quality” as dependent variables and “knowledge representation form” as independent variable for the first set of hypotheses. After this, the visualization are compared to each other, “time” and “answer quality” are used as dependent variables and “visualization form” as a dependent variable.

4 EMPIRICAL RESULTS

The forms of knowledge representation in this study are designed in a way which allows to access the performance of actual visualization in contrast to simplification. The forms in this study are based on the similar samples of text and since they are not simplified and nothing is removed, they are more complex than they could have been. However, this complexity allows to assess the difference in comprehension between text and visualizations which are similar to text in complexity, with the only difference in the logic structuring of visualizations. The following research is aimed to establish the effect of this pure visualization on knowledge sharing time and quality when it is performed by business school students who are the sample from the population of managers.

4.1 Analysis of the knowledge sharing time difference between forms of knowledge representation

The sample consists of 76 business school students whose time to extract knowledge from the each of three given forms was measured; therefore the total is 228 time observations. Figure 8 is the mapping of all 228 interview results.

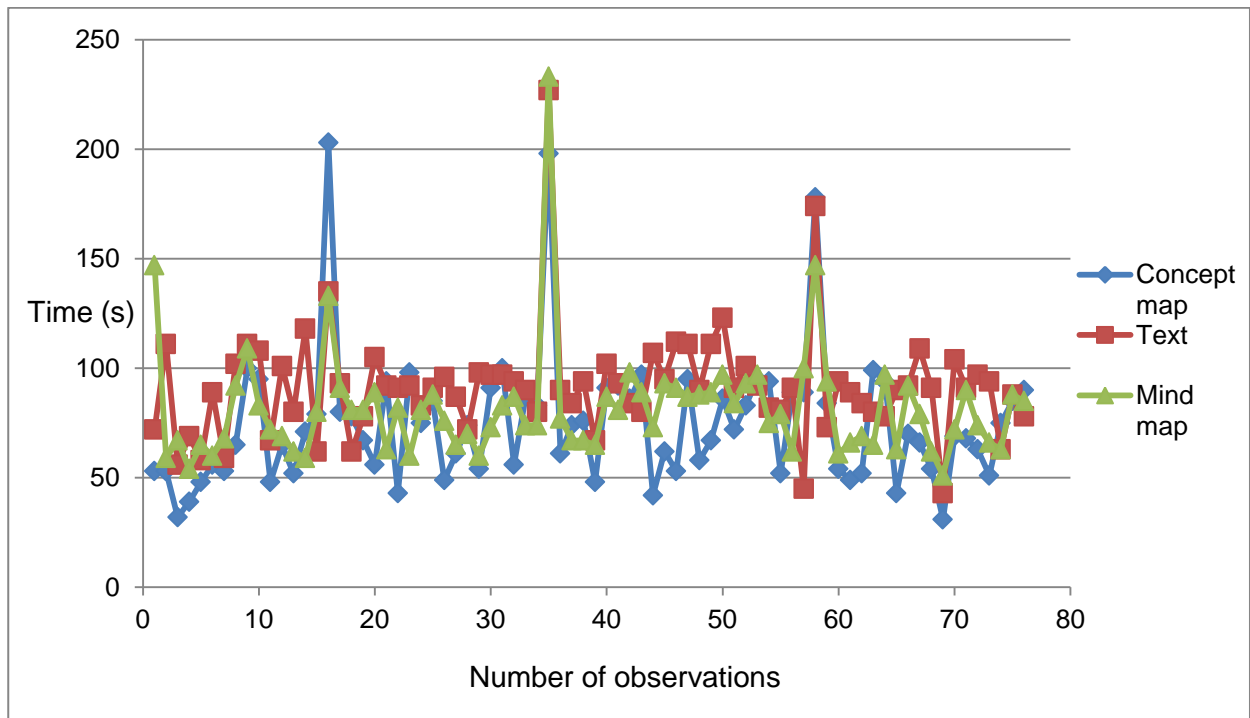


Figure 8. Mapping of time observations.

It can be clearly seen that the time it takes to acquire knowledge from each form is around the same and it varies between 50 and 100 seconds with few outliers. It is important to note that the outliers typically occur for a group of observations because they depend on the approach of an interviewed individual which is usually the same for each form.

Figure 9 has the mapping of mean times to extract knowledge from three forms. It is visible that on average, it takes the longest for an individual to extract knowledge from the text compared to similar visualizations. Among the visualizations, concept maps have on average a small advantage when compared to mind maps. It is an interesting result, because the interviewed students often claimed that concept maps and mind maps were harder for them than the common textual form. Despite this, it still took less time for the interviewees to extract knowledge from visualized structured forms.

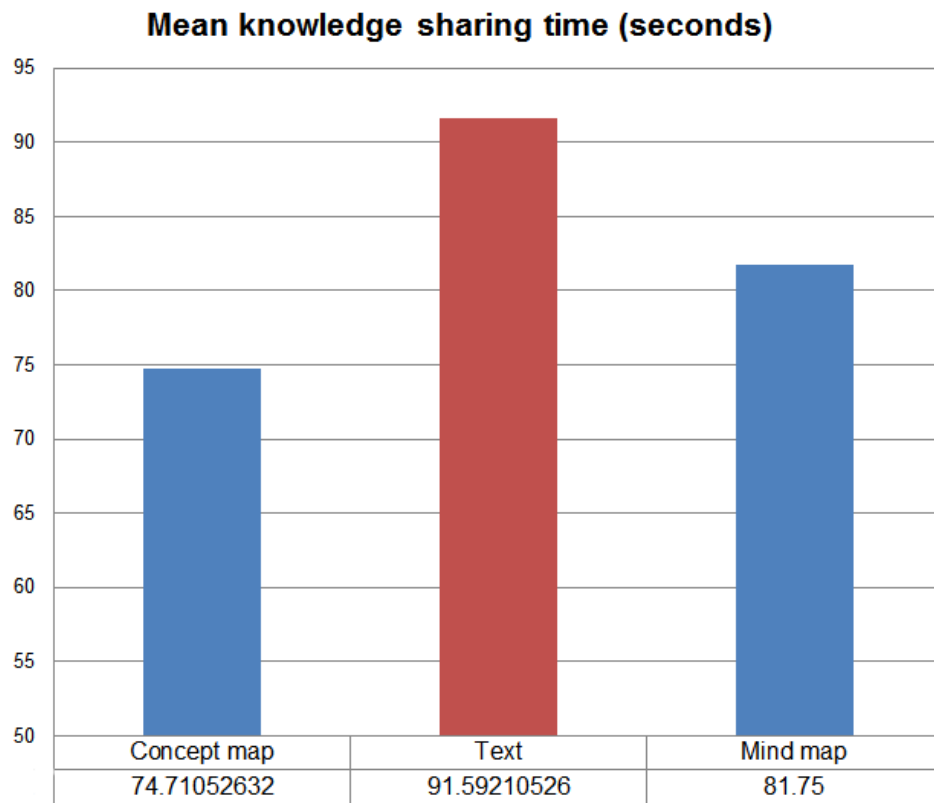


Figure 9. Mean knowledge sharing time chart.

In order to test H1 (The difference in time of knowledge sharing through text, mind maps and concept maps is statistically significant), it is necessary to run a one-way ANOVA test with time as dependent variable and three forms as a factor. The first hypothesis serves as a primary proof of difference between various forms of knowledge representation.

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between groups	10929.026	2	5464.513158	7.482526	0.000714
Within groups	164318.237	225	730.303275		

Total	175247.263	227			
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Table 1. ANOVA results.

With the significance of 0.000714 (Table 1) and a significance level of 0.05 the hypothesis H1 is not rejected, which means that the reviewed forms of knowledge do differ in knowledge acquisition time for the sample, with text being the form it takes the longest to extract knowledge from.

4.2 Analysis of knowledge sharing quality difference between forms of knowledge representation

Figure 10 shows all response quality observations mapped on a chart. Quality observations are way more random compared to time observations, and they are evenly spread between 1.5 and 4.5 points.

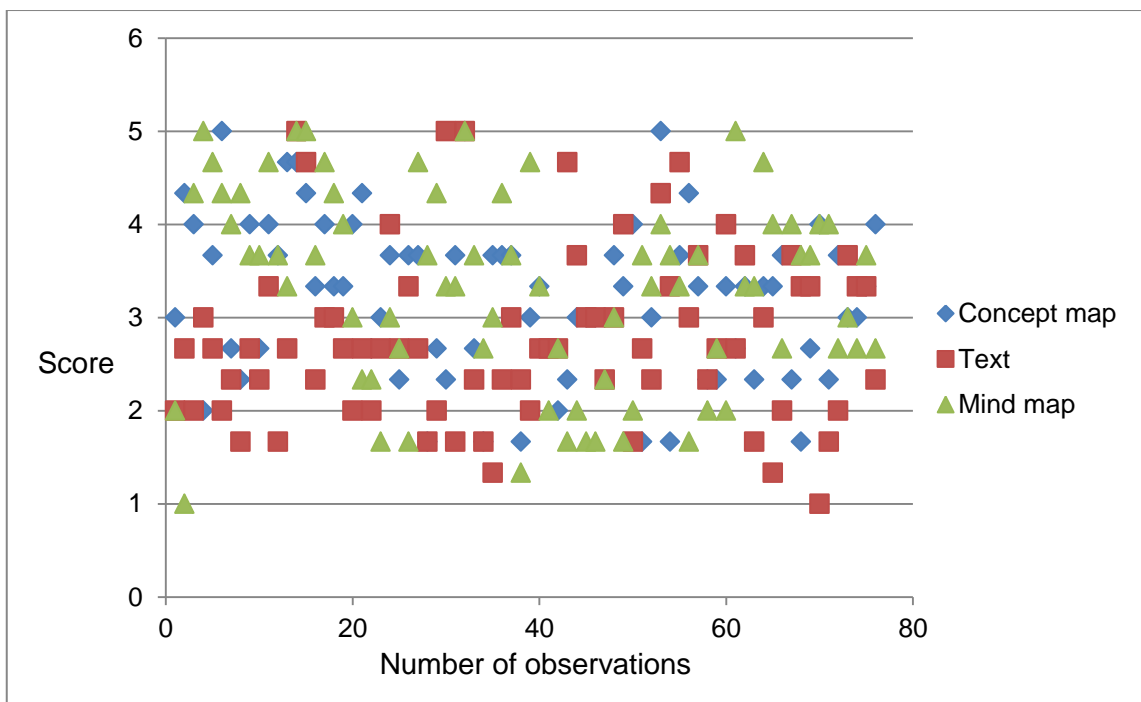


Figure 10. Mapping of quality observations.

Figure 11 shows the mean quality chart. Text, on the average, shows the lowest knowledge sharing quality of 2.8 points out of 5. It is followed by concept maps and mind maps with the average quality of 3.2 and 3.3 respectively.

This is an interesting result compared to the previous results of time of knowledge sharing. It would seem self-evident that the speed of knowledge sharing with the use of visualization will be offset by the lower quality of knowledge internalization. However, the quality is also higher in the case of visualization. This thus means that the effect of mapping of logical connections has a positive effect on both time and quality of knowledge sharing and it can thus benefit knowledge management practices within an enterprise.



Figure 11. Mean quality chart.

In order to test H2 (The difference in quality of knowledge sharing through text, mind maps and concept maps is statistically significant), one way ANOVA test

(Table 2) is being conducted with “quality” as a dependent variable and knowledge representation form as an independent variable.

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between groups	11.133	2	5.567	6.297	0.002
Within groups	198.896	225	.884		
Total	210.029	227			

Table 2. ANOVA results.

With the significance of 0.002 and a significance level of 0.05 the hypothesis H2 is not rejected, and the forms of knowledge do differ in knowledge acquisition quality for the sample, with text being the form with the lowest quality of knowledge sharing.

4.3 Analysis of the knowledge sharing time difference between visualizations

This part examines the performance of visualizations when they are compared to each other. In previous hypotheses, even complicated visualizations performed better than text. However, concept maps and mind maps were pretty close to each other in terms of both time and quality. Figure 12 shows the means of comprehension time for these two forms of visualizations. Mind maps have a bigger comprehension time of 81.75 seconds compared to the mean time of concept maps of 74.71 seconds.

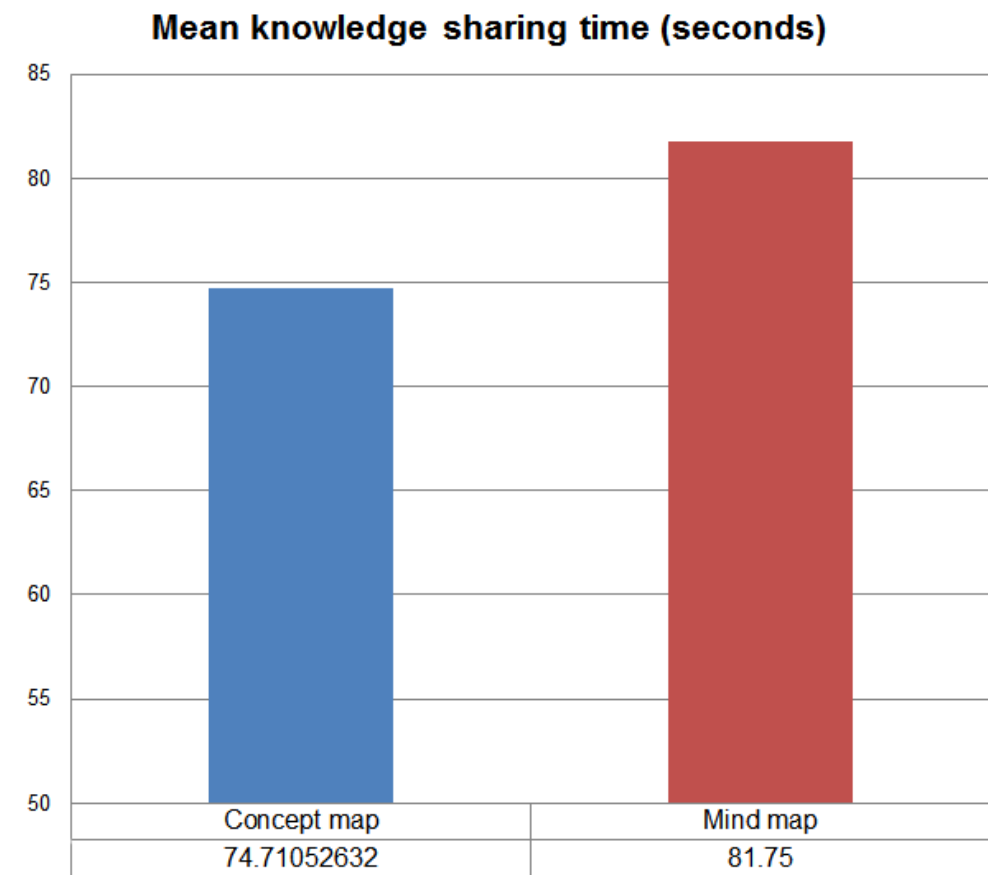


Figure 12. Mean knowledge sharing time for visualizations.

In order to test H3 (The difference in time of knowledge sharing through visualizations is statistically significant) it is necessary to run a one-way ANOVA test (Table 3).

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between groups	1883.059	1	1883.059	2.415	0.122

Within groups	116981.882	150	779.879		
Total	118864.941	151			

Table 3. ANOVA results.

Since the significance level is 0.05, ANOVA significance of 0.122 allows to reject the H3 hypothesis. This rejection makes it possible to state that visual forms of explicit knowledge reviewed in this study do not differ in knowledge sharing time for this sample.

4.4 Analysis of knowledge sharing quality difference between visualizations

Figure 13 shows the mean response quality for visualizations. Generally the response quality is pretty similar for both forms (3.2 and 3.3 points out of 5), especially compared to text (2.8 points out of 5).

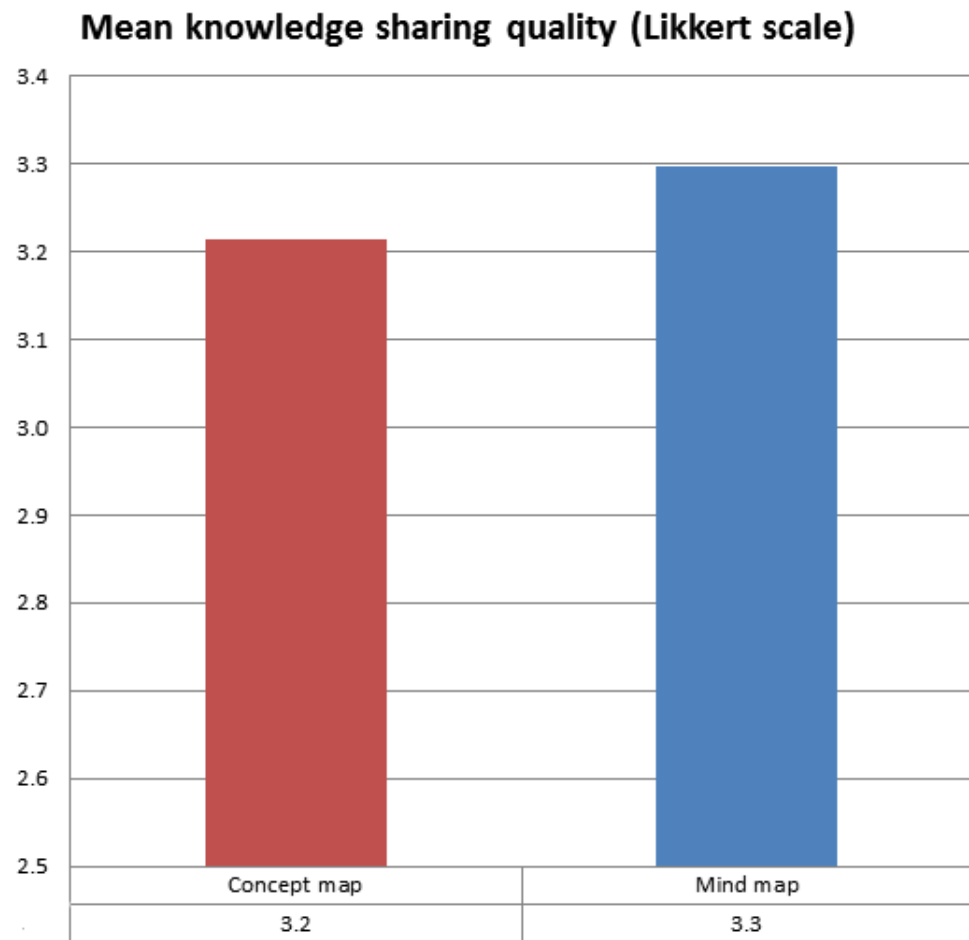


Figure 13. Mean knowledge sharing quality for visualizations.

ANOVA test is performed to test the H4 (The difference in quality of knowledge sharing through visualizations is statistically significant).

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between groups	0.295	1	0.295	0.328	0.568
Within groups	134.986	150	0.900		
Total	135.281	151			

Table 4. ANOVA results.

ANOVA results (Table 4) back the similarity of quality means from Figure 13. The significance of 0.568 is way past the significance level of 0.05, which allows to reject H4 and state that there the difference between comprehension quality of mind maps and concept maps is not statistically significant.

In conclusion, the results of analyses are in favor of visualization. Both hypotheses on difference of time and quality results of text and visualizations were not rejected, and while text had the both longest sharing time and lowest sharing quality, it can be stated that it is the least efficient form of knowledge transfer compared to visualizations. Text as a form has its own advantages, for instance it's the cheapest and fastest form of knowledge to produce compared to visualized forms which take more time to be created, however the efficiency of knowledge transfer and retention can easily outweigh the costs in ever-changing competitive environment.

The following table (Table 5) is the summary of the hypotheses tested in this study.

H1: The difference in time of knowledge sharing through text, mind maps and concept maps is statistically significant	Not rejected. Time of knowledge sharing is the biggest for text sample, followed by mind maps and concept maps.
H2: The difference in quality of knowledge sharing through text, mind maps and concept maps is statistically significant.	Not rejected. Average quality of the responses to questions on the text sample is the lowest, while the quality of responses for mind maps and concept maps is significantly higher, with mind maps performing slightly better.
H3: The difference in time of knowledge sharing through visualizations is statistically significant.	Rejected. Even though mean knowledge sharing time is smaller for concept maps, the difference between it and the time to extract knowledge from mind maps is not statistically significant.

H4: The difference in quality of knowledge sharing through visualizations is statistically significant.	Rejected. The similar mean quality scores in both concept and mind maps are supported by statistical research which found no significant difference between the groups.

Table 5. Summary table.

5 DISCUSSION

The study of a sample of business students revealed visualization to be the form which has the best time and quality efficiency in knowledge sharing. It is extremely important in the context of the experimental knowledge forms which were designed for this study. The forms were based on similar samples of text without any knowledge omissions thus removing the factor of abstraction from visualizations which always was their main competitive advantage over text. The visualizations in this study, namely concept maps and mind maps were relatively complicated, which made it possible to assess the effect of low-level visualization. The only difference of this low-level visualization over the text form is that the visualized forms have their logical connections exposed to the reader. Despite this exposure, the visualizations might seem to be complicated from the first glance. However, despite the complicity, the visualized forms had on average significantly smaller values of knowledge sharing time and the response quality mapped on a Likkert scale from 1 to 5 has also showed significantly greater performance of visualizations over text.

Thus, statistical prevalence in efficiency of both mind maps and concept maps over text has some significant theoretical and managerial implications.

5.1 Theoretical implications

The implications which this work has for the theory can be divided into two main categories: implications for the part of theory of knowledge management related to the forms of explicit knowledge, and generally for the theory of knowledge-based view of the firm.

The implications for forms of explicit knowledge support the notion of positive effect of visualization on knowledge sharing (Buzan 1974, Eppler 2006, Davies 2011, Gavrilova et al. 2014). For instance, Buzan (1974) argues that mind maps enhance learning. The evidence of this study supports it with mind maps being

the form of knowledge which has better mean knowledge sharing time of 81 seconds compared to 91 seconds of text in the reviewed sample. Aside of that, mind maps have the best knowledge sharing quality score of mean 3.3 points which makes them more efficient than concept maps which had an average score of 3.2 out of 5.

Eppler (2006) also argues that the extensive use of visualizations in various knowledge sharing contexts has shown numerous benefits achieved by applying visual mapping techniques that foster the graphic reconstruction of knowledge. The evidence of this study backs this notion with statistical research; visual forms indeed prove themselves to be the containers of knowledge with the best knowledge sharing time and quality parameters.

Aside of that, Eppler (2006) divides mind maps and concept maps along the lines of several different characteristics. In the respective study he argues that the main advantage of concept maps is rapid information provision, and this notion is also backed by this research which found concept maps to be the fastest form of knowledge in knowledge sharing process with mean time of 74 seconds compared to 91 seconds which it takes a person to extract knowledge from the text with same amount of knowledge. This research disagreed with Eppler (2006) in complexity of mind maps. According to Eppler, mind maps can be idiosyncratic and hard for others to read. However, statistical research and the reviews of the interviewed individuals provide evidence that mind maps are not harder to work with compared to concept maps. The difference in both time and quality of knowledge sharing for both these visual forms is very slight and is not statistically significant.

The second part of theoretical implications is related to the generic knowledge-based view of the firm. According to Grant (1996), Kogut and Zander (1992) knowledge is an extremely important resource for any knowledge-intensive enterprise, and proper knowledge management can foster the company's performance. Even though this study did not measure the company-wide effect of better knowledge sharing practices within an enterprise but only individual perception, some enterprise-related conclusions can still be made. Generally the

evidence of this study supports the knowledge-based view of the firm. Better knowledge management, even as local as more efficient forms of knowledge provided to an individual, can significantly improve knowledge sharing performance.

Better time and quality of knowledge sharing properties of some forms of knowledge over another might play an important role in knowledge management of an enterprise and reduce the information overload which many managers face. Less time spent on sharing of knowledge from an explicit source means efficient time management and a possibility for a manager and thus the company to be more efficient. Better quality of knowledge sharing means that less of important knowledge is missed, which thus creates more opportunities for efficient decision-making. Aside of that, more efficient knowledge management with less effort and more knowledge acquired leaves more room for innovation.

5.2 Managerial implications

Better time and quality of knowledge sharing brought by the usage of visual forms have important managerial implications. Since visual forms are more efficient than text, the main managerial implication calls for more widespread usage of visual forms in business. Currently forms like mind maps or concept maps are mostly used during business presentations to sum up certain findings. However, these forms might also be used in casual day-to-day activities. Since the effect of knowledge structuring in the visible form is evident, better knowledge sharing time and quality would make knowledge management within a company more efficient.

For instance, it can be advised for the knowledge-intensive companies to render their reporting in the structured visual form. Aside of obvious benefits of faster and better understanding of the knowledge which is shared in the company, the structured knowledge is a resource which is different from unstructured textual

mass of knowledge, and it can be used in a greater knowledge management perspective.

The structured visual forms of knowledge, if they are built using the same principles and the same agreed upon dictionary of terms, can be a basis of ontology within an enterprise. This means that these forms of knowledge can be easily united into an ontological knowledge management system of an enterprise which would incorporate all knowledge of the company. Thus, the usage of structured forms of knowledge can lead to knowledge management systems of a whole new level of efficiency.

5.3 Limitations

The main limitation of the study is connected to the sample used in the study. The sample consists of business school students which are used as a proxy to test the possible reactions of managers to various forms of knowledge. However, students are a different group and the things which apply to students may not fully apply to managers. Aside of that, the students in the sample are mostly 22-24 years old and often have limited work experience, which thus means that the population under consideration should be younger managers of 20-30 years of age.

Second, not all possible forms of knowledge have been investigated in the study. It is not possible to encompass every single form of knowledge representation in this type of study; therefore it was necessary to pick only several of them. This study reviewed the textual form of knowledge representation and two most popular visual forms, namely mind maps and concept maps. Another limitation might be the size of the form of knowledge. It is possible and efficient to convert medium amounts of business-related knowledge to structured visual forms, however it is possible that it is less efficient for managers to deal with large masses of knowledge converted to visual forms, however this effect has to be additionally researched. One more limitation is connected to the possible issues

of fit of knowledge into various visual forms. As it has been already discussed, concept maps focus on connections while mind maps concentrate on groupings and generalizations. Thus, various pieces of knowledge, which, for instance, might have more connections between concepts than generalizations, might be more suitable for concept maps. Thus, this effect of the knowledge content on the choice of the knowledge representation form has to be additionally estimated.

Third, this study investigated only individual experiences with forms of knowledge with some company-wide assumptions which were made on the basis of individual experiences. Even though the knowledge sharing within a company typically consists of interactions between individuals or of individuals extracting knowledge from some sources and it is thus possible to estimate the positive effect of better knowledge sharing on the performance of knowledge management within a company, this estimate is still indirect.

5.4 Further research directions

This study investigated into the issue of effect of form of knowledge representation on the knowledge management efficiency. However, this study had some necessary limitations which are outlined above. Therefore, the primary future research objectives are connected to the limitations of a master thesis study.

First, it is possible to increase the sample and compose it out of actual managers. This would make the study more relevant to business and would estimate how actual managers perceive various forms of knowledge. Second, it would be great to expand the amount of forms used in such study and add less known firms, knowledge sharing potential of which is not yet estimated. Third, a more comprehensive study can be made which would attempt to estimate the direct effect of different forms of knowledge on the knowledge management

within a company. It is a possible case study when the managers are provided with different forms of knowledge to operate in their day-to-day activities with the outcome measured with a set of designed KPIs.

Aside of that, a more comprehensive study can be made which would advance the topic of structured forms of knowledge to the domain of ontologies. It can also be a case study like the previous suggestion, however it would not just implement new forms of explicit knowledge to the company, but it would go as far as to unite it into an ontological framework of knowledge management within a company. This extremely comprehensive study would be able to look into the future ways of knowledge management in the knowledge-intensive competition.

6 CONCLUSIONS

Knowledge sharing takes place in pretty much every significant human interaction. It is an important part of knowledge management, which has extreme importance for all enterprises, especially knowledge-intensive ones. Visualization is a recent trend, which, according to many scientists, can help knowledge sharing, knowledge acquisition and innovation. This study researched the effect of pure visualization on the efficiency of knowledge sharing, namely on two most important features of this activity: time and quality of knowledge sharing.

This study was designed with the specific purpose of establishing the effect of visualization on knowledge sharing and it followed an elaborated experimental pattern. The specific questionnaire was created, which is suited to test the pure effect of visualization on knowledge sharing. Typically visualization implies simplification and thus it is easy to claim that the visualization is more efficient because it is simple. However the visualizations in this study were deliberately complex and as close to text as possible in terms of amount of knowledge stored in order to assess the unbiased effect of visualization and knowledge structuring on knowledge sharing. The questionnaire featured three forms of knowledge representation: text, mind maps, concept maps. All of three sample forms were based on similar pieces of text which had about the same amount of knowledge. The mind map and the concept map did not lack any pieces of knowledge compared to text, the only difference is that they were structured. Mind maps are based on the principle of grouping notions on the basis of a similar level of granularity, while concept maps mostly focus on the connections between the notions, and the difference between these forms and the text is that those connection and logical structures are explicitly shown in visualizations, while in the textual form it is required for the individual to create these logical connections from the scratch.

The sample and the interview have also been designed in a way to exclude all possible biases. The population which is under investigation is the managers. However the sample which is used consists of business schools students, who

have the managerial background, who possibly have some experience in business and who are soon to be employed, yet the students might differ in knowledge sharing properties compared to senior managers with years of experience. Thus, the population has been limited to younger managers of 20-30 years of age. The interviews have been carried out face-to-face, first the interviewee was presented with a form of knowledge, then the knowledge sharing time was measured and the interviewee was asked carefully crafted questions, which addressed equal amounts of knowledge just acquired by an individual. During every interview the sequence of forms has been shuffled, to avoid the bias when the first forms are harder for an individual compared to the following ones. As a result, 76 interviews have been conducted with LUT and GSOM students.

The evidence of the study is in favor of visualization. Two main hypotheses on the difference in time and quality of knowledge transfer between forms of explicit knowledge were not rejected which provides solid evidence for the better performance of visualized forms compared to text.

The visualized forms of knowledge do not only differ from text in terms of knowledge sharing performance. Visualized forms also provide structured knowledge in contrast to the unstructured text. Structured knowledge unlocks a whole new level of knowledge management. If knowledge is structured, it can be described each time with the help of a common vocabulary, which will allow to use the ontological approach. In practice, ontological knowledge system would consist of computers which would be able to store and provide access to the whole database of company's knowledge coded in a machine-readable form.

In the post-industrial era, when knowledge is a crucial resource, the call for efficient knowledge management will raise the bar to the point when constant handling of textual and often paper-based knowledge sources will be an extreme competitive disadvantage. Therefore, it is the goal of knowledge-intensive companies to anticipate the future changes and prepare for the new era of competition in knowledge management.

Since structured visualized forms tend to perform better even in basic individual comprehension, they might be the first step towards the ontological knowledge management. It is impossible to install complex ontological systems without appropriate corporate culture, where employees are familiar with the structured forms of knowledge representation. Thus, the regular usage of visualizations turns out to be an extremely important milestone in the company's knowledge management practices, which would eventually allow enterprises which prefer structured data over unstructured data mass to transcend to most efficient ontological systems of future years.

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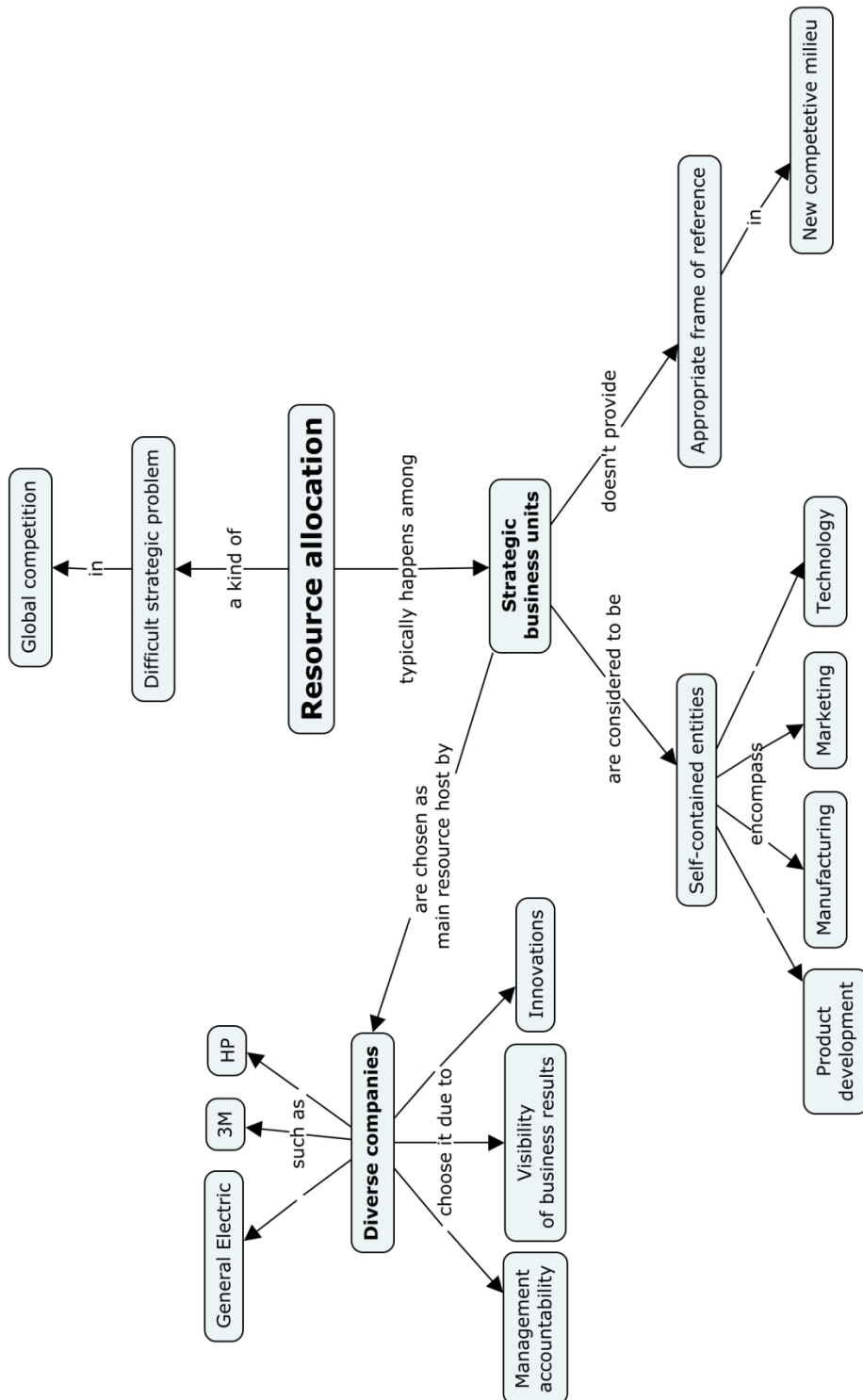
APPENDIX 1 – DATA SET

	Knowledge sharing time (seconds)			Average knowledge sharing quality (Likkert-like scale)		
№	Concept map	Text	Mind map	Concept map	Text	Mind map
1	53	72	147	3.0	2.0	2.0
2	53	111	59	4.3	2.7	1.0
3	32	56	67	4.0	2.0	4.3
4	39	69	54	2.0	3.0	5.0
5	48	58	65	3.7	2.7	4.7
6	56	89	60	5.0	2.0	4.3
7	53	59	68	2.7	2.3	4.0
8	65	102	92	2.3	1.7	4.3
9	100	111	109	4.0	2.7	3.7
10	95	108	83	2.7	2.3	3.7
11	48	67	72	4.0	3.3	4.7
12	65	101	69	3.7	1.7	3.7
13	52	80	62	4.7	2.7	3.3
14	71	118	59	4.7	5.0	5.0
15	79	62	80	4.3	4.7	5.0
16	203	135	133	3.3	2.3	3.7
17	80	93	91	4.0	3.0	4.7
18	78	62	81	3.3	3.0	4.3
19	67	78	81	3.3	2.7	4.0
20	56	105	89	4.0	2.0	3.0
21	94	92	63	4.3	2.7	2.3
22	43	91	82	2.7	2.0	2.3
23	98	92	60	3.0	2.7	1.7
24	75	83	81	3.7	4.0	3.0
25	85	91	88	2.3	2.7	2.7
26	49	96	76	3.7	3.3	1.7
27	61	87	65	3.7	2.7	4.7
28	74	72	70	1.7	1.7	3.7
29	54	98	60	2.7	2.0	4.3
30	91	97	73	2.3	5.0	3.3
31	100	97	83	3.7	1.7	3.3
32	56	94	87	5.0	5.0	5.0
33	87	90	74	2.7	2.3	3.7
34	83	80	74	1.7	1.7	2.7

35	198	227	233	3.7	1.3	3.0
36	61	90	77	3.7	2.3	4.3
37	74	84	67	3.7	3.0	3.7
38	76	94	67	1.7	2.3	1.3
39	48	67	65	3.0	2.0	4.7
40	91	102	87	3.3	2.7	3.3
41	92	93	81	2.7	2.7	2.0
42	86	84	98	2.0	2.7	2.7
43	97	80	89	2.3	4.7	1.7
44	42	107	73	3.0	3.7	2.0
45	62	95	93	3.0	3.0	1.7
46	53	112	91	3.0	3.0	1.7
47	95	111	87	3.0	2.3	2.3
48	58	90	88	3.7	3.0	3.0
49	67	111	89	3.3	4.0	1.7
50	86	123	97	4.0	1.7	2.0
51	72	91	84	1.7	2.7	3.7
52	83	101	93	3.0	2.3	3.3
53	95	92	97	5.0	4.3	4.0
54	94	82	75	1.7	3.3	3.7
55	52	81	79	3.7	4.7	3.3
56	89	91	62	4.3	3.0	1.7
57	89	45	100	3.3	3.7	3.7
58	178	174	147	2.3	2.3	2.0
59	84	73	94	2.3	2.7	2.7
60	54	94	61	3.3	4.0	2.0
61	49	89	66	2.7	2.7	5.0
62	52	84	69	3.3	3.7	3.3
63	99	80	65	2.3	1.7	3.3
64	94	78	97	3.3	3.0	4.7
65	43	90	63	3.3	1.3	4.0
66	70	92	92	3.7	2.0	2.7
67	66	109	79	2.3	3.7	4.0
68	54	91	62	1.7	3.3	3.7
69	31	43	51	2.7	3.3	3.7
70	69	104	72	4.0	1.0	4.0
71	68	91	90	2.3	1.7	4.0
72	63	97	74	3.7	2.0	2.7
73	51	94	66	3.0	3.7	3.0
74	75	63	63	3.0	3.3	2.7
75	85	88	88	3.3	3.3	3.7
76	90	78	85	4.0	2.3	2.7

APPENDIX 2 – EXPERIMENTAL QUESTIONNAIRE

Knowledge form sample: Concept map



Adapted from: Hamel, G. and C.K. Prahalad. 1985. Do you really have a global strategy? *Harvard Business Review* 63: 139-148.

Knowledge from questions: Concept map

- What is the issue of resource allocation within strategic business units?
- Which companies use the concept of SBU resource allocation?
- Why do companies choose resource allocation within SBUs?

Knowledge form sample: Text

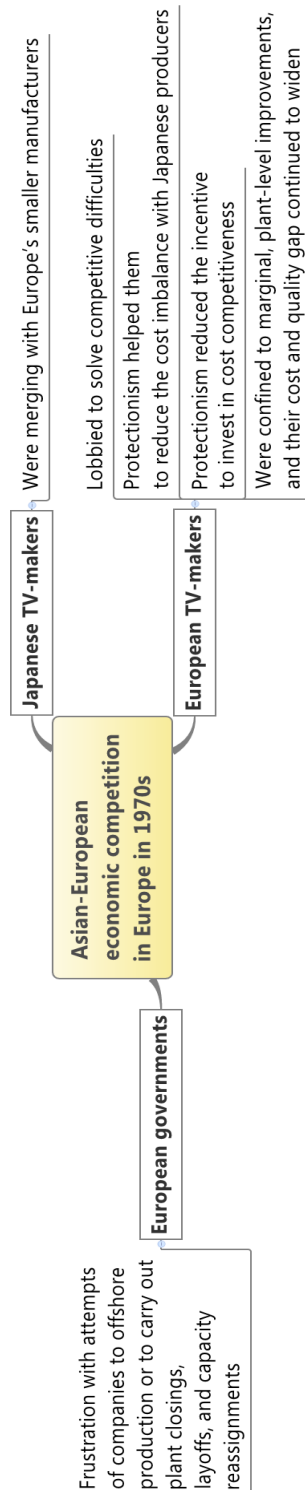
Just as they had not been content to remain private-label suppliers in the United States, Japanese companies were not content to remain component suppliers in Europe. They wanted to establish their own brand positions. Sony, Matsushita, and Mitsubishi set up local manufacturing operations in the United Kingdom. When, in response, the British began to fear a Japanese takeover of the local industry, Toshiba and Hitachi simply found U.K. partners. In moving assembly from the Far East to Europe, Japanese manufacturers incurred cost and quality penalties. Yet they regarded such penalties as an acceptable price for establishing strong European distribution and brand positions.

Source: Hamel, G. and C.K. Prahalad. 1985. Do you really have a global strategy? *Harvard Business Review* 63: 139-148.

Knowledge form questions: Text

- What is the main discontent of Japanese companies?
- Which companies set up their own manufacturing in the United Kingdom?
- How did Japanese companies regard cost and quality penalties while moving their production from the Far East to Europe?

Knowledge form sample: Mind map



Adapted from: Hamel, G. and C.K. Prahalad. 1985. Do you really have a global strategy? *Harvard Business Review* 63: 139-148.

Knowledge form questions: Mind map

- What were the concerns of the European governments?
- What was the strategy of the Japanese companies?
- How did protectionism affect the European firms?