

Can You Picture It? - The use of knowledge visualisation in knowledge transfer

International Business Communication
Master's thesis
Janika Niskanen
2012

Can You Picture It? – The use of knowledge visualisation in knowledge transfer

Objectives of the Study

The objective of the study was to examine the problem of knowledge transfer when knowledge was communicated to decision makers with specific knowledge visualisation methods. The case company of the study, Company A, is an international market intelligence company operating in Finland and offering solutions, services and consultancy to various organizations. The study examined Company A's clients' reactions to conceptual diagrams and visual metaphors in order to answer the main research questions: 1A. Could conceptual diagrams be used for knowledge transfer to Company A's customers' decision makers? 1 B. Could visual metaphors be used for knowledge transfer to Company A's customers' decision makers?

Methodology

A quantitative single-case study was conducted with two separate online surveys among the decision makers of Company A's Finnish clients. One survey examined the use of conceptual diagrams, and the other one surveyed visual metaphors.

Findings and Conclusions

The main findings of the study suggest that conceptual diagrams and visual metaphors may lead to an illusion of understanding, and that both visualisation methods would need text to support understanding. The main findings also indicate that knowledge cannot be reliably transferred with either of the two visualisation methods when no supporting text is provided. The findings further suggest that decision makers find conceptual diagrams as a more suitable visualisation method for business reports than visual metaphors. Finally, the results of the study indicate that the decision makers were more confident that they understood the message signalled through conceptual diagrams than through visual metaphors, while at the same time visual metaphors seemed to transfer the message better. Based on the results, recommendations of the use of conceptual diagrams and visual metaphors were given to Company A.

Keywords

knowledge communication, knowledge transfer, knowledge visualisation, international business communication

Osaatko kuvitella? – Tiedon visualisoinnin käyttö tiedon välittämisessä

Tutkimuksen tavoitteet

Tutkimuksen tavoitteena oli tarkastella tiedon välittämistä (knowledge transfer) päätöksentekijöille tiedon visualisoinnin menetelmin. Tutkimuksen kohteena ollut tapausyritys, Yritys A, on kansainvälinen markkina- ja kilpailijaseurantaa (Market Intelligence) tekevä yritys, joka toimii Suomessa ja tarjoaa erilaisia ratkaisuja, palveluita ja konsultointia monenlaisille organisaatioille. Tutkimus selvitti Yritys A:n asiakkaiden reaktioita käsitteellisiin diagrammeihin ja visuaalisiin metaforiin tavoitteenaan löytää vastaukset tutkimuskysymyksiin, jotka olivat seuraavat: 1A. Voitaisiinko käsitteellisiä diagrammeja käyttää tiedon välittämiseen Yritys A:n asiakkaiden päätöksentekijöille? 1B. Voitaisiinko visuaalisia metaforia käyttää tiedon välittämiseen Yritys A:n asiakkaiden päätöksentekijöille?

Tutkimusmenetelmät

Tutkimus käytti menetelmänään kvantitatiivista yksittäistä tapaustutkimusta. Tiedon hankintaan käytettiin kahta erillistä nettipohjaista kyselyä, joista toinen sisälsi käsitteellisiä diagrammeja ja toinen visuaalisia metaforia. Kysely tehtiin Yritys A:n suomalaisten asiakkaiden päätöksentekijöille.

Tutkimuksen tulokset ja johtopäätökset

Tutkimuksen keskeisimmät tulokset viittaavat siihen, että sekä käsitteellisten diagrammien että visuaalisten metaforien käyttö voi johtaa ymmärryksen illuusioon. Lisäksi molemmat visualisointitavat vaatisivat tekstiä tukemaan ymmärtämistä. Keskeisimmät tulokset osoittavat, että tietoa ei voida luotettavasti välittää kummankaan visualisointimenetelmän avulla, mikäli ymmärtämistä tukevaa tekstiä ei ole tarjolla. Tutkimustulokset viittaavat siihen, että päätöksentekijät näkevät käsitteelliset diagrammit sopivampana visualisointimenetelmänä yritysraportteihin kuin visuaaliset metaforat. Tulokset näyttäisivät lisäksi osoittavan, että päätöksentekijät olivat varmempia siitä, että he ymmärsivät visualisoinnilla välitetyn viestin kun aihe oli visualisoitu käsitteellisellä diagrammilla. Kuitenkin samanaikaisesti tiedon välittäminen onnistui paremmin visuaalisten metaforien avulla. Tuloksiin perustuen Yritys A:lle annettiin suosituksia käsitteellisten diagrammien ja visuaalisten metaforien käyttöön.

Avainsanat

tiedon kommunikointi, tiedon visualisointi, tiedon välittäminen, kansainvälinen yritysviestintä

ACKNOWLEDGEMENTS

I would like to take this opportunity to thank Professor Martin J. Eppler for bringing to my attention the fields of knowledge communication and knowledge visualisation. Thank you to sales people for contacting customers. A special thank you to my colleague, Product Management Director, for our productive exchange of ideas. Many thanks to my professor for her kind guidance. A great thank you to those who have proofread my text.

Finally, thank you to all my friends and family who have been incredibly understanding of my physical and emotional absence from social events, and who have at times forced me out or brought me ice cream. I would especially like to thank my sister for her great patience with me.

The shortest answer is doing the thing.
- *Ernest Hemingway*

TABLE OF CONTENTS

ABSTRACT/ TIIVISTELMÄ	2
ACKNOWLEDGEMENTS	3
TABLE OF CONTENTS	4
LIST OF TABLES	6
LIST OF FIGURES	6
1 INTRODUCTION	8
1.1. Company A	9
1.2. Justification of the present thesis	10
1.3. Knowledge communication.....	11
1.4. Knowledge visualisation.....	13
1.5. Overview of the research topic.....	15
1.6. Research objectives and questions	18
1.7. Definitions of the key terms.....	19
1.8. Structure of the thesis.....	19
2 LITERATURE REVIEW	21
2.1 Visualising knowledge	21
2.1.1. Data, information and knowledge	21
2.1.2. Information visualisation and knowledge visualisation	23
2.1.3. Benefits of visual representation	25
2.1.4. Knowledge transfer	26
2.1.5. Visual metaphors and conceptual diagrams	29
2.1.6. Limitations of visualisations	33
2.2. Theoretical framework.....	36
3 METHODS AND DATA.....	41
3.1. Methods and Data.....	41
3.1.1. Single-case study	41
3.1.2. Data collection and question design	43
3.1.3. Sample structure	48

3.1.4. Data analysis.....	51
3.2. Trustworthiness of the study	51
3.2.1. Validity.....	52
3.2.2. Reliability	54
4 FINDINGS	56
4.1. Matter 1: Market Intelligence functions supporting decision making.....	56
4.2. Matter 2: Development levels of Market Intelligence function	59
4.3. Matter 3: Value chain analysis	62
4.4. Matter 4: Forces of competition	65
4.5. Comparison of the results	68
5 DISCUSSION AND CONCLUSIONS	74
5.1. Discussion of findings	74
5.2. Research summary	80
5.2. Practical implications	83
5.3. Limitations of the present study	85
5.4. Suggestions for further research.....	89
REFERENCES	91
APPENDICES	97
Appendix 1. Survey of conceptual diagrams	97
Appendix 2. Survey of visual metaphors.....	104
Appendix 3. Translation of conceptual diagrams survey	111
Appendix 4. Translation of visual metaphors survey	117
Appendix 6. Cover letter	123
Appendix 7. Translation of cover letter	124

LIST OF TABLES

Table 1.	Demographic features of the respondents	51
Table 2.	Age distribution by gender.	52
Table 3.	Answers for questions 1 and 2 in Matter 1.	61
Table 4.	Answers for questions 1 and 2 in Matter 2.	64
Table 5.	Answers for questions 1 and 2 in Matter 3.	67
Table 6.	Answers for questions 1 and 2 in Matter 4.	70
Table 7.	Overview of all the visualisations used in surveys.	71
Table 8.	Number and percentage of respondents who indicated that they understand the message of visualisation.	72
Table 9.	Percentage of the respondents who offered correct answers to both claims.	72
Table 10.	Percentages of respondents considering visualisation suitable for their company reports.	74
Table 11.	Visualisations regarded as suitable for Company A's deliverables.	87

LIST OF FIGURES

Figure 1.	Focus of the study.	15
Figure 2.	Research topic.	17
Figure 3.	Research topic niche.	18
Figure 4 .	Examples of conceptual diagrams: Pyramid, Circle, Process and Flowchart.	33
Figure 5.	Shannon's schematic diagram of a general communication system.	37
Figure 6.	Simplified diagram of a communication system.	40
Figure 7.	Theoretical framework of the present study.	41
Figure 8.	Modified theoretical framework of the present study.	42
Figure 9.	Example of a survey page.	48
Figure 10.	Conceptual diagram 1. Market Intelligence functions supporting decision making.	59

Figure 11.	Visual metaphor 1. Market Intelligence functions supporting decision making.	60
Figure 12.	Conceptual diagram 2. Development levels of the Market Intelligence function.	62
Figure 13.	Visual metaphor 2. Development levels of the Market Intelligence function.	63
Figure 14.	Conceptual diagram 3. Value chain analysis.	65
Figure 15.	Visual metaphor 3. Value chain analysis.	66
Figure 16.	Conceptual diagram 4. Forces of competition.	68
Figure 17.	Visual metaphor 4. Forces of competition.	69
Figure 18.	Reformed framework of the present study.	81

1 INTRODUCTION

Throughout human history, from cave paintings to Leonardo Da Vinci's sketches, people have expressed themselves and their thoughts with visualisations. Today's modern technologies have brought new ways to create and present visualisations. In addition, in the modern business world with its accelerating pace of work life it has become more and more important to gather and understand the information needed for strategic decision making. Furthermore, the pool of information available has become overwhelming. Thus it is today common for companies to use outsourced market intelligence to collect important information. While consultants do the work of processing the information for decision makers, the question of transferring the processed information from consultants to decision makers has become critical. This transfer needs to be done successfully and efficiently. As the human brain has a natural ability to process pictures (Burkhard 2004b), we could ask that if this natural ability should be used in the context of business communication to create and transfer knowledge, as well as reduce the information overload (e.g. Eppler and Burkhardt 2007), which has been defined by Burkhard (2004a, p.1) as a situation where "decision makers cannot identify the relevant information".

There exists evidence to support the belief that knowledge can be transferred through visualisations (e.g. Alavi and Leidner 2001; Eppler and Burkhardt 2007). Knowledge visualisation is a new field studying the creation and transfer of knowledge and reduction of information overload with the help of visualisations. The knowledge visualisation field has just recently started to receive more attention from research and business communities (Cañas, Carff, Hill, Carvalho, Arguedas, Eskridge, Lott, and Carvajal 2005, p.181).

Even though knowledge visualisation is a relatively new field, Eppler, Platts and Kazancioglu (2006 p.38) claim that visualisation will be part of the future business language – "a language that integrates diagrams, text, visual metaphors, and symbols to make better use of strategic content". Furthermore, Eppler and Burkhardt (2006, pp. 7–

8) believe that knowledge visualisation “is an idea whose time has come”. However, as Burkhard (2004a, p.2) argues, today’s managers are still not familiar with all the different visualisation possibilities offered by the modern world. According to Burkhard (2004a) managers merely limit themselves to the use of certain types of visualisation tools, such as clip arts, diagrams and PowerPoint slides. Therefore, the present thesis examines the possibility of using other visualisation methods in the context of PowerPoint, a familiar tool frequently used in different kinds of deliverables.

Being a new field of research, knowledge visualisation has not yet been studied extensively. Moreover, the studies conducted in knowledge visualisation have been in the context of e.g. business meetings (e.g. Bresciani, Blackwell and Eppler 2008b) and business strategies (e.g. Kernbach and Eppler 2010), but the use of visualisations in business deliverables remains less examined. The present thesis is a single case study on visualisations that could be used in the case company’s deliverables to its clients. For confidential reasons the case company will be called Company A. The purpose of the present thesis is to study the means of visualisation in Company A’s deliverables. The practical implications of the present study should help Company A’s consultants to use knowledge visualisation in future reports.

1.1. Company A

Company A is an international market intelligence company operating in Finland. Company A offers solutions, services and consultancy to organizations from various industries. Company A’s clients order research or monitoring to support their decision making and delivering market intelligence reports to clients according to their needs, is one of Company A’s activities. In order to make a useful report to the client, Company A’s consultants need to be able to convey the knowledge they have gained through the research to the client. The information in the reports needs to be transformed into knowledge in the receiver’s mind and ultimately to the actions of the decision maker.

The present author has worked in Company A for several years and is thus familiar with the case company's operations and needs. To gain even more contextual knowledge, the Product Management Director of Company A was pre-interviewed to determine the final research topic.

In Company A there exists a need for knowing more about such visualisation methods that could be used in the context of consulting. Some visualisations have been used in Company A's reports, but visualisation is not coherent throughout the reports and the use is based on an individual consultant's competence. No study on the effectiveness of the visualisations used has been conducted. Company A would like to understand more of the use of visualisations that would help in knowledge transfer from the consultant to the client's decision maker. Through this understanding, the final goal of Company A is to make the consultants' work more efficient and effective.

Burkhard (2004b, p.7) describes different decision makers' targets. Some of them are presented here to give an example of Company A's clients' needs. As an example of strategic targets Burkhard (2004b, p.7) mentions e.g. competitor analysis and strategic planning. He also mentions economic targets, for example shifts in demand, and targets of operations, e.g. business process analysis. The decision makers of Company A's clients come across with e.g. these targets, which could be examined with methods of market intelligence. The deliverables related to for example the above targets could utilize different visualisation methods to facilitate understanding.

1.2. Justification of the present thesis

The justification for the present case study is twofold. Firstly, it will be beneficial for Company A as it meets their need to develop knowledge communication with visualisation methods in their reports. Secondly, the study should also be beneficial to other consultant companies aiming at developing visual communication in their deliverables. In addition, the present study will contribute to research of knowledge

visualisation which still remains as an emerging field (e.g. Eppler and Burkhard 2004; see also 2006; 2007; Hanratty, Hammell, John, McNeese, Oh, Kim, Minotra, Strater, Cuevas and Colombo 2009; Lengler and Eppler 2007). Moreover, Bresciani and Eppler (2010, p. 359) argue that experimental quantitative studies comparing the effectiveness of different visualisations are needed. Burkhard (2004a, p.4) argues that even though in the transfer of knowledge the recipient is in an important role, not enough studies have examined the role of the recipient. The present thesis seeks to study knowledge transfer mainly from the recipient's point of view.

The present thesis project is conducted within the field of international business communication. The case company of the present thesis is an international company operating in international markets. Company A's best practices are shared in all offices around the world. Thus, even though the present study is conducted among Company A's Finnish clients the results of the study will be shared among other offices around the world. In addition, most of Company A's clients operate internationally. Moreover, knowledge visualisation is an important area of interest of knowledge communication which again is a field of study under the larger field of communication. Hence, the present thesis is well positioned in the field of international business communication.

1.3. Knowledge communication

Because knowledge visualisation is a method to communicate knowledge, one needs to understand the concept of knowledge communication, in order to do research in knowledge visualisation. According to Eppler (2007, p. 292) in knowledge communication knowledge is communicated in a context which differs from communicating merely facts or data. Eppler (2007, p.291) suggests the following definition for knowledge communication: "one can view knowledge communication as the (deliberate) activity of interactively conveying and co-constructing insights, assessments, experiences, or skills through verbal and non-verbal means". This definition has been adopted to the present thesis.

Eppler (2007, p. 291; see also Eppler & Burkhard 2007, p.3) explains that there are different types of knowledge that can be transferred with knowledge communication: know-how, know-why, know-what and know-who. Eppler and Burkhard (2007, p.113) clarify that know-how means procedural knowledge; experimental knowledge is understood as know-why; know-what is the kind of knowledge that is declarative; and know-who stands for people-related knowledge. In addition, they introduce two more knowledge types; location-based knowledge, know-where and scenario-based knowledge, know-what-if. Alavi and Leidner (2001, pp.110–113) have come up with a similar distinction, but they call declarative knowledge ‘Know-about’.

The present thesis focuses on visualising declarative knowledge with knowledge visualisation methods and the term know-what will be used to describe the concept of declarative knowledge. Know-what is considered the most suitable knowledge type for the present thesis as Company A has a need to communicate know-what, so that the decision makers of their clients understand the results of Company A’s research or monitoring, and the insights the reports are trying to convey.

Eppler (2007, p. 292) further explains that different types of knowledge can be transferred synchronously i.e. in real time, or asynchronously, which means delayed interaction. The present thesis will be concentrating on Company A’s deliverables presented in PowerPoint, which is the most common file format of Company A’s deliverables. Here, the PowerPoints represent a form of asynchronous knowledge communication because the files are sent to clients to be read by themselves.

Above it was presented that the present thesis will concentrate on communicating know-what. Eppler (2007, p. 292) stresses that in addition to *what* is communicated, in knowledge communication it is equally important *how* it is communicated. Eppler (2007, p. 292) mentions visualisation as a method to communicate expertise-based and complex insights. This knowledge communication type is called knowledge visualisation.

1.4. Knowledge visualisation

Tergan, Keller and Burkhard (2006, p.168) argue that “knowledge visualization is a field of study that investigates the power of visual formats to represent knowledge. It aims at supporting cognitive processes in generating, representing, structuring, retrieving, sharing, and using knowledge”. Eppler and Burkhard (2006, p. 1) note that: “the field of knowledge visualization examines the use of visual representations to improve the creation and transfer of knowledge between at least two people”. This definition has been widely applied in the field (e.g. Burkhard, 2004a, p.2; Burkhard, 2004b, p.2; Cañas et al., 2005, p.181). Eppler and Burkhard (2006, p. 1) continue that, “knowledge visualization thus designates all graphic means that can be used to construct and convey complex insights”. Eppler and Burkhard (2006, p. 1) point out that knowledge visualisation is not just presenting facts, but also for example transferring insights, predictions and experiences and showing relations. This is what differentiates knowledge visualisation from information visualisation. They further describe that the transferring is done in “a way that enables someone else to re-construct, remember, and apply these insights correctly (Eppler and Burkhard 2006, p. 1)”. Accordingly, knowledge visualisation is a relevant concept to the present study as it is important that Company A’s customers internalize the information presented in the deliverables, remember it and know how to act according to it in the decision making situation.

Eppler and Burkhard (2006, pp.1-2) note that another distinction between information visualisation and knowledge visualisation is that the latter does not necessarily rely on computer-based visualisation methods. However, as the reports produced by Company A’s consultants are mostly delivered in an electronic format and, more importantly, as this study focuses on deliverables in the PowerPoint format, the present thesis examines computer-based knowledge visualisation methods.

Another reason supporting the decision to focus on computer-based knowledge visualisation methods is the fact that the visualisations in the reports need to be of professional quality and have high perceived finishedness. Perceived finishedness defines how finished or open to changes the visualisation is. Hence perceived

finishedness is high when the illustration seems like a finished visualisation and low when it appears to be more like a sketch (Bresciani, Blackwell, and Eppler 2008b, p.4). Bresciani et al. (2008b, p.4) disclose that the possibility to make modifications to the visualisation should be coherent with the perception of finishedness. The possibility to change the visualisation in Company A's reports should be seen low. Consequently high perceived finishedness is an important feature for the knowledge visualisation types to be examined. The knowledge visualisation types chosen for the present study also need to fit for the PowerPoint format. Therefore visual metaphors and conceptual diagrams were chosen as the knowledge visualisation types to be examined in the present study.

Figure 1 indicates that the present study will concentrate on communicating *know-what* asynchronously with computer based visualisation methods in a knowledge visualisation context.

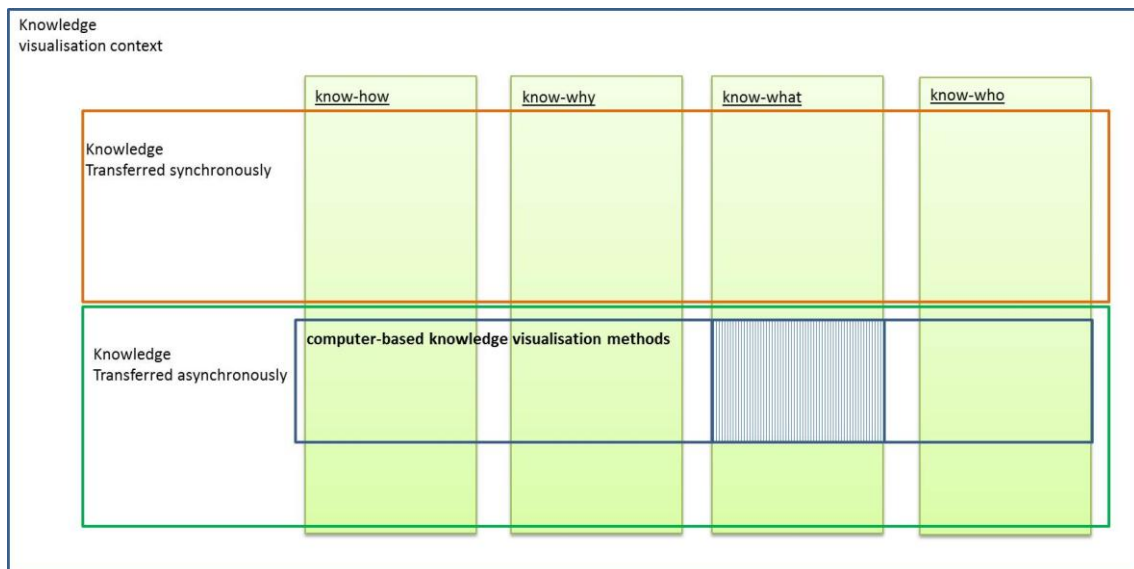


Figure 1. Focus of the study.

||||||| = The area of interest

The focus area of the present study can be further specified according to possible application areas for knowledge visualisation. Eppler and Burkhart (2006) mention such application areas as (1) *knowledge transfer*, (2) *knowledge creation* and (3) *knowledge visualisation as a tool against information overload*. *Knowledge transfer* means that the

receiver recreates the communicated knowledge in his own mind (El Sawy, Eriksson, Carlsson and Raven 1997, p.11) Eppler & Burkhart define (2006, p.2; see also Eppler & Burkhart 2007, p.120) *knowledge creation* as creating new knowledge collectively through innovation. According to Eppler and Burkhart (2007, p.120) knowledge-intensive organisations suffer from information overload. *Knowledge visualisation as a tool against information overload* is an effective strategy to avoid information overload because it enables compressing the information (Eppler & Burkhart 2006, p.2; Eppler and Burkhart 2007, p.120).

From the application areas of *knowledge transfer*, *knowledge creation* and *knowledge visualisation as a tool against information overload* two can be seen as aims of Company A's deliverables. Knowledge transfer would ensure that the decision makers of the client get the intended message, and as Company A's customers work in knowledge-intensive positions; visualisation can be used as a mean to decrease the information overload in the reports. However, it was essential to narrow the focus of the present study and therefore the present thesis will concentrate on knowledge transfer.

In the present thesis knowledge visualisation is understood as a way to convey complex insights with visual means so that the receiver can remember them and act according to them.

1.5. Overview of the research topic

To conclude, and to offer an example of knowledge visualisation, the topic of the present thesis is presented below with visual metaphors which are supported with descriptive text.

Universe of knowledge communication

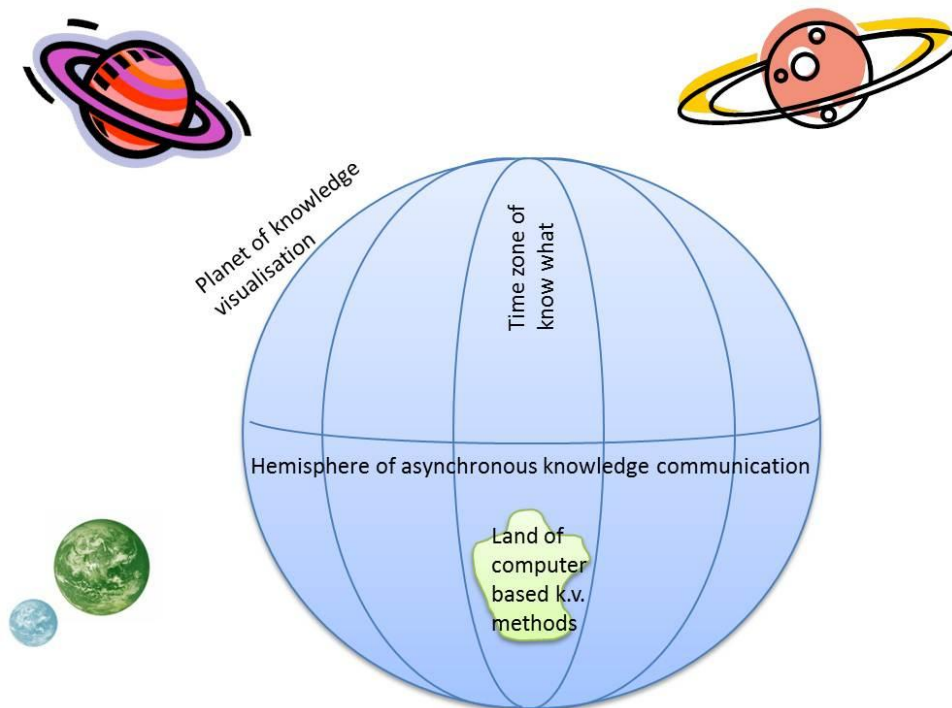


Figure 2. Research topic.

Figure 2 illustrates the research topic of the present thesis with a visual metaphor. Figure 2 presents that in the universe of knowledge communication there exists a planet of knowledge visualisation. The universe of knowledge visualisation refers to the general field of knowledge communication where the knowledge visualisation is one area of interest. In the planet of knowledge visualisation there exist two hemispheres; hemispheres of synchronous and asynchronous knowledge communication. The present study focuses on asynchronous knowledge transfer, which means delayed interaction. The different time zones in the planet of knowledge visualisation present the different knowledge types that can be transferred, e.g. know-how, know-why, know-what and know-who. In Figure 2 the time zone of know-what is visible as declarative knowledge i.e. *know-what* is the knowledge type that the present study focuses on. Figure 2 also displays the land of computer based knowledge visualisation methods. This means that

in the planet (area) of knowledge visualisation there exist different types of visualisation methods, but the study focuses on those that can be computer based.

Figure 3 further illustrates the particular niche for the present study. Of the available computer based knowledge visualisation methods the present study is interested in those that are suitable for the PowerPoint format. In Figure 3 this has been visualised in the way that in the land of computer based knowledge visualisation methods, there is a county of PowerPoint. Additionally, Figure 3 illustrates that there exist different types of application areas for knowledge visualisation. Here knowledge transfer, knowledge creation and the information overload, are presented as different slopes of the ground. The forests of knowledge visualisation have been highlighted because the present study focuses on knowledge transfer. However, in the forest of knowledge transfer there exist many different visualisation methods to be focused. Metaphorically these different methods may be referred to as different types of trees. Figure 3 illustrates that the present theses is interested in the trees of visual metaphors and those of conceptual diagrams.

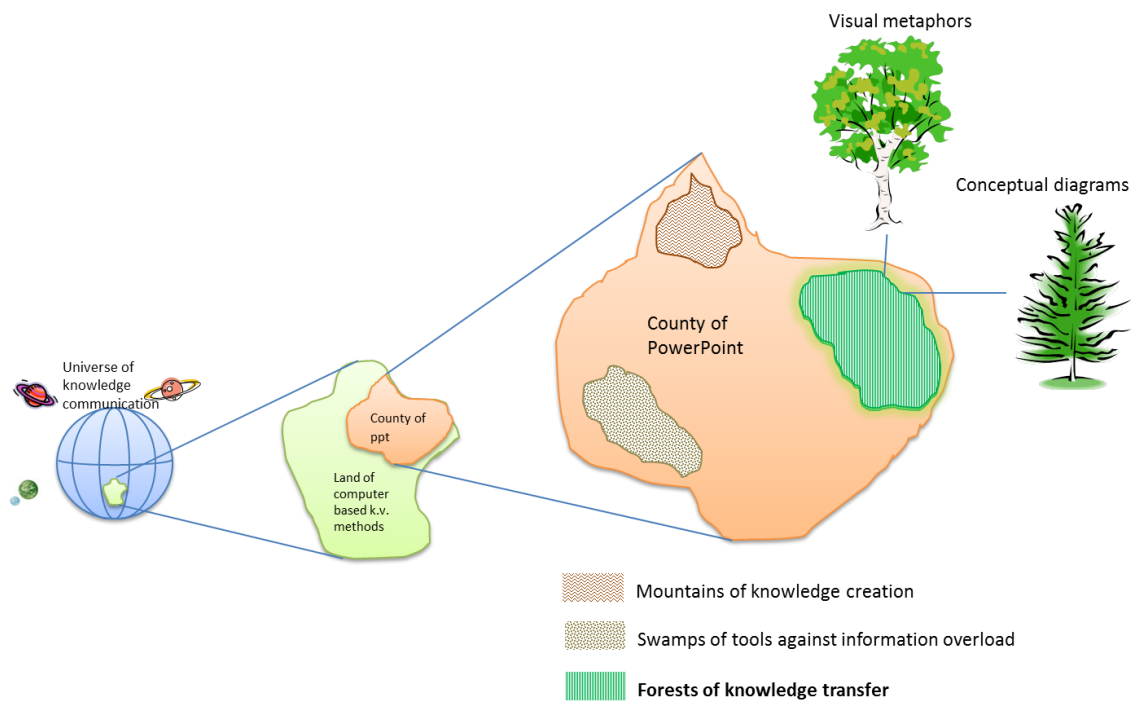


Figure 3. Research topic niche.

To summarize, the present thesis focuses on knowledge visualisation presented in visual metaphors and conceptual diagrams as means of asynchronous knowledge communication to transfer know-what knowledge to Company A's customers.

1.6. Research objectives and questions

The present thesis examines Company A's clients' reactions to specific knowledge visualisation methods. In other words, the thesis investigates if the clients find these methods helpful for knowledge transfer.

The objective is to examine the problem of knowledge transfer to Company A's customers' decision makers with specific knowledge visualisation methods.

This thesis will address the following two research questions:

- 1 A. Could conceptual diagrams be used for knowledge transfer to Company A's customers' decision makers?
- 1 B. Could visual metaphors be used for knowledge transfer to Company A's customers' decision makers?

These questions will be considered from two perspectives. Firstly, it will be investigated how the decision makers react to the visualisation methods and secondly, the questions will be addressed from the knowledge transfer point of view.

The present thesis will find out about Company A's clients' reactions to different visualisations and based on the findings, it will be suggested which visualisation means could be preferred in future deliverables.

1.7. Definitions of the key terms

As the field of knowledge visualisation is reasonably new, this subchapter offers definitions for the key terms used in the present thesis. All the key terms are discussed more thoroughly in Chapters 1 and 2 but short definitions are offered here to facilitate reading. In the present thesis the terms of *knowledge communication*, *knowledge visualisation*, *knowledge transfer* and *know-what* are understood as follows:

Knowledge communication

The (deliberate) activity of interactively conveying and co-constructing insights, assessments, experiences, or skills through verbal and non-verbal means (Eppler 2007, p.291).

Knowledge visualisation

A way to convey complex insights with visual means so that the receiver can remember them and act according to them.

Knowledge transfer

The receiver of a message acts as a learner and recreates the communicated knowledge in his own mind.

Know-what

Declarative knowledge

1.8. Structure of the thesis

This thesis is divided into five chapters. Chapter 1 first established the topic and niche of the present thesis and then introduced the research questions. Chapter 2 reviews literature and previous research on knowledge communication and related fields of study, as well as presents the theoretical framework. Chapter 3 introduces the research design and methods as well as discusses the trustworthiness of the study. Chapter 4

presents the results of the study. The final Chapter 5 summarises the study and discusses the findings, practical implications, limitations of the study and suggestions to future research.

2 LITERATURE REVIEW

The purpose of this chapter is to establish the research area of the present study. The topic and terminology of the thesis were already introduced to some extent in the introduction chapter. This chapter focuses on a more thorough discussion on the key areas and on defining the key terms. Finally, this chapter aims at developing the theoretical framework of the present thesis. The first section of this chapter reviews relevant literature on visualising knowledge and the second section of this chapter presents the theoretical framework.

2.1 Visualising knowledge

The purpose of this section is to review relevant literature and provide an overview of the relevant topics for the present thesis. This section is divided into six subsections each concentrating on one specific topic. First, the difference between data, information and knowledge is elaborated. Second, differences in information and knowledge visualisation are discussed. Third, the benefits of visualisations are considered. Fourth, the concept of knowledge transfer is introduced. Fifth, the use of conceptual diagrams and visual metaphors as knowledge visualisation methods in the present thesis is motivated and finally, limitations of visualisations are discussed.

2.1.1. Data, information and knowledge

The present thesis focuses on knowledge visualisation, which is an area of interest in knowledge communication. The following definition for knowledge communication was given in Chapter 1: “one can view knowledge communication as the (deliberate) activity of interactively conveying and co-constructing insights, assessments, experiences, or skills through verbal and non-verbal means (Eppler 2007, p.291)”. This definition is accepted in the present thesis. Moreover, it was earlier presented that in

knowledge communication, knowledge is communicated in a context which differs from communicating merely facts or data (Eppler 2007, p. 292). Then, it is argued that data differs from knowledge. Thus, differences between the concepts of data, information and knowledge are discussed here.

Bellinger, Castro, and Mills, (2004) regard data as raw, as merely symbols that just exist and have no meaning of themselves, whereas information, according to them, is data that has been processed and gets its meaning through a relational connection. Tergan and Keller (2005, p.3) adopt these definitions and enunciate that different people can have different interpretations, and if a person does not see the meaning in data it remains as data to him/her. Tergan and Keller (2005, p.3) point out that information can be abstract or concrete. They argue that information has different categories, e.g. facts or opinions, and it may be presented in different formats, for example, in a verbal or visual format.

Bellinger et al. (2004) argue that already memorising information is knowledge, and thus they introduce the concept of understanding, which according to them is an analytical learning process relating new knowledge to old knowledge. However, Tergan and Keller (2005, p.4), understand these defining aspects of understanding actually being aspects of knowledge. Also Cañas et al. (2005, p.182) associate meaningful learning, as well as integrating new information into old information, with knowledge. Tergan and Keller (2005, p.4) further describe that in order for information “to become knowledge, it has to be processed, furnished with meaning, and integrated into [...] mental knowledge structure”.

Alavi and Leidner (2001, p.109) note that according to a common view, data refers to merely numbers and facts, processed data is called information, and authenticated information is knowledge (e.g., Dreske 1981; Machlup 1983; Vance 1997). However, as the insights presented above have implied, Alavi and Leidner (2001, p.109) think that “rather, knowledge is information possessed in the mind of individuals: it is

personalized information”. They also consider that (p.109) information becomes knowledge when people process it in their minds.

As discussed above in earlier literature there have been some differences in understanding when information changes into knowledge. In the present thesis data will be seen as raw symbols and information is understood as processed data, e.g. facts that are presented. It is the understanding of the present thesis that information becomes knowledge when it is understood and given a meaning in the mind of an individual. Further, the present thesis also builds on Alavi and Leidner (2001, p.110), who point out that as knowledge is personalised, the communicator needs to express it in a way that allows the receiver to interpret it, and on Tergan and Keller (2005, p.4), who offer solution to this by mentioning that it is possible to externalize some aspects of knowledge with visualisation.

2.1.2. Information visualisation and knowledge visualisation

The field of knowledge visualisation emerges from the tradition of information visualisation. To establish the place of knowledge visualisation for the present study, the commonalities and differences between these two fields are discussed here.

One way to communicate insights is through visual means (e.g. Tergan and Keller 2005, p.4) According to Card, Mackinlay and Shneiderman (1999, p. 1) graphical inventions are important external aids to increase thinking, memory and reasoning, as they serve two important goals. Firstly, they help to communicate an idea and secondly to discover the idea if it does not exist already. Card et al. (1999, p. 6) note that visualisations carry insights that help to discover, make decisions and explain. They outline information visualisation as “the use of computer-supported, interactive, visual representations of abstract data to amplify cognition” (Card et al. 1999, p.7). Card et al.’s definition is widely accepted (e.g. Burkhart 2004a, p.2).

Card et al. (1999; see also Card, 2007; Purchase, Andrienko, Jankun-Kelly and Ward 2008; Ware, 2004) bind information visualisation tightly to computer based methods. Eppler and Burkhardt (2006, p.1; see also Burkhardt 2005, p.244) consider this as a defining difference between information visualisation and knowledge visualisation; knowledge visualisation uses non-computer based visualisation methods as well as computer based.

Information visualisation is also typically seen as visualisation of large amounts of data (e.g., Eppler and Burkhardt 2006; Burkhardt et al. 2007; Keim 2002; Tergan and Keller 2005; Ware, 2004). This data can be two-, three-, or multidimensional (Keim 2002). According to Purchase et al. (2008, p.48) exploring data to obtain understanding is the main purpose of information visualisation. While information visualisation focuses on presenting great amounts of data to show or reveal ideas, knowledge visualisation helps to create and transfer complex knowledge, as Eppler and Burkhardt (2006, p.1) outline. Moreover, Bresciani et al. (2008a, p.2) state that information visualisation visualizes primarily quantitative data and the actual communication of opinions, assessments and insights is left for knowledge visualisation. In addition, Tergan and Keller (2005) present that information visualisation can use two-, tree- and multi-dimensional visualisation methods, whereas knowledge visualisation is generally limited to two-dimensional methods. Burkhardt (2004a, p.2) sums up the difference between purposes of use as follows: whereas information visualisation examines data trying to generate new insights, knowledge visualisation's goal is to improve knowledge transfer.

Bresciani and Eppler (2009 p. 474) outline that the research of information visualisation often conducts analysis on quantitative diagrams, and "focuses on the formal aspects of specific graphic solutions in terms of their thinking and/or communication support", while Tergan et al. (2006, p.168) argue that research of knowledge visualisation focuses on situations of interfunctional knowledge transfer. In these situations the insight must be transferred to stakeholders within a short period of time.

2.1.3. Benefits of visual representation

Knowledge can be communicated with a variety of means. This subsection discusses the benefits of visual representation in order to motivate the use of visualisations in attempts to communicate knowledge.

Previous studies have indicated that visual representation has distinct benefits over the textual format. This has to do with the human brain's natural ability to process pictures (Burkhard 2004b). Burkhard (2004b, p.3) explains that "A majority of our brain's activity deals with processing and analysing visual images. Images are pre-attentive and processed before text". Eppler and Burkhart (2007, p.120; see also Ware 2007 p. 28) support the idea that images are processed more effortlessly than text. Accordingly, it does not take as much time and effort to process images as it takes to process text. Eppler (2003, p.105) argues that using visualisations is one of the best methods to make information accessible and comprehensive as well as to compress information. In addition Ware (2007 p. 29) argues that visualisations are good tools because they can present a lot more complex ideas than can be stored in visual or verbal working memories. Even though all the information cannot be stored in working memories, with visualisation it can all be displayed at the same time and this helps to understand the complex information.

Worren, Moore and Elliott (2002, p.13; see also Tergan and Keller, 2005) find that visualising complex relationships helps to overcome working memory limitations. These limitations include both capacity limitations and limitations concerning of how long information can be stored (Tergan 2006, p.168). Eppler and Burkhart (2006, p. 2) discuss that verbal recall appears to lose in comparison to visual recall. Eppler and Burkhart (2006, p. 2) have also reached the conclusion that peoples' thinking and communicating abilities can be increased radically when visualisations are used appropriately.

Eppler and Burkhart (2006, p. 7; see also Burkhard 2005, p.245) conclude six benefits for visualisation. Firstly, visualisations make coordination of a group and group

communication easier. Secondly, visualisations attract attention. Thirdly, with the use of visual representation it is possible to increase recall and memorability. Fourthly, visuals can motivate the receiver and fifthly, deepen their understanding. Finally, visual representation can help to create new insights.

Burkhard (2004b, p.14) claims that knowledge visualisation improves knowledge transfer among decision makers. He continues that with knowledge visualisation information quality and communication can be improved, possibility to misinterpretation and to information overload can be reduced, and therefore the quality of decisions can be made better. Misinterpretation means, according to Burkhard (2004a, p.1), that “decision makers cannot understand, evaluate and interpret the information”.

It was presented above that visual representations have many benefits. Thus it should be highlighted that as many of these benefits are connected to the natural abilities of the human brain these benefits should therefore be exploited.

2.1.4. Knowledge transfer

It was outlined in the Chapter 1 that out of different application areas of knowledge visualisation, the present study focuses on knowledge transfer. Thus the concept of knowledge transfer is discussed in this subsection.

According to El Sawy et al. (1997, p.11) knowledge transfer differs from information transfer. They emphasize that in the transfer of information a message sender conveys a message and a message receiver apprehends it as it is, whereas in the transfer of knowledge the receiver acts as a learner recreating the knowledge in his own mind. Thus, recreating knowledge in the receiver’s mind can be related to learning. Recreating knowledge in the mind of a receiver seems to have become the defining element for

knowledge transfer (e.g. Eppler and Burkhart 2006, p. 2; Alavi and Leidner 2001, p.120; Gururajan and Gardiner 2004, p.2).

Gururajan and Gardiner (2004, p.2) emphasise the meaning of learning in the transfer process. Novak and Govin (1984) argue that learning can be seen as relating new knowledge to something we already know. Consequently, knowledge transfer is connected to relating new knowledge to old knowledge as well as assisting the learning process. These functions have been seen as functions of certain visualisation types, for example visual metaphors (Eppler and Burkhart, 2006; Eppler and Burkhart, 2007), which is one of the knowledge visualisation methods studied in the present thesis. Tergan et al. (2006,p.167) take this approach even further and argue that the aim of knowledge visualisation is to assist learning and problem solving.

However, knowledge transfer has certain requirements that have to be met. For example, the cognitive capacity of the receiver affects the success of the transfer (e.g. Eppler and Burkhart 2006, p. 2; Alavi and Leidner 2001, p.120). Furthermore, Eppler and Burkhart (2006, p. 2) note that the sender who transfers knowledge must convey the knowledge not just at the right time and in the right context but also to the right person. Accordingly, Burkhard (2004a, p.2) points out that the person transferring knowledge needs to consider how much time the receiver has, how detailed information the receiver needs, what is the cognitive background of the receiver and if the information is relevant to him/her. Burkhard, (2004b, p.9) further accentuates the need to customise the message according to the recipient's cognitive background so that the reconstruction of the knowledge becomes equivalent to the intentions of the sender. Moreover, Ringberg and Reihlen (2008) remind that private and cultural models of people also affect the reconstruction of knowledge. These models are affected by socio-cultural interaction and receiver's cognitive dispositions e.g. creativity and emotions (Ringberg and Reihlen 2008, p.912). Cherry (1966, p. 182, 271) also highlights the importance of receivers prior knowledge and past experience.

Knowledge transfer can be made from individual to individual, from individual to group, from group to group and so on (Alavi and Leidner 2001, p.119). There also exist different channels for knowledge transfer. Alavi and Leidner (2001, p.120) note that these channels can be formal or informal and personal or impersonal. These defining details have been identified here with a purpose of establishing the ground for the reader.

In the present thesis communication between Company A's consultants and decision makers can be seen as inter-functional communication, where the transfer is made from individual to individual or from individual to group, i.e. from the consultant to decision makers. Eppler and Burkhart (2007, p.119) argue that knowledge visualisation can help with inter-functional knowledge transfer. In the present thesis the assumption is that the decision makers read the deliverables by themselves, thus the transfer is examined from the individual to individual point of view. Because the presumption of the thesis is that Company A's deliverables are delivered to clients in a PowerPoint format and that the decision makers of the clients study the reports by themselves, it can be concluded that Company A uses formal and impersonal ways to transfer knowledge.

According to Eppler and Burkhart (2007, p. 119; see also Eppler and Burkhart 2006, p. 6) knowledge transfer can take place through knowledge visualisation. Furthermore, Eppler and Burkhart (2006, p. 2) find transferring complex knowledge with visualisation methods as a sub-discipline for knowledge visualisation. Eppler and Burkhart (2006, p. 1) mention that visual metaphors and conceptual diagrams, among other visualisation methods, "are used as indirect (and at times ambiguous) communication in order to trigger sense-making activities and to motivate viewers to reconstruct meaning". Hence, it is concluded that knowledge transfer can be done through visual metaphors and conceptual diagrams.

2.1.5. Visual metaphors and conceptual diagrams

It was concluded that visual metaphors and conceptual diagrams can be used as visualisation methods in knowledge transfer, which is the focus application area of knowledge visualisation in the present thesis. These visualisation methods are viewed in the present subsection.

Lengler and Eppler (2007, p. 1) define visualisation methods as follows: “A visualization method is a systematic, rule-based, external, permanent, and graphic representation that depicts information in a way that is conducive to acquiring insights, developing an elaborate understanding, or communicating experiences”.

Above it was argued that choosing the right context, time and person, as well as taking into account the receivers’ time and other restrictions when transferring knowledge are important. Additionally, when choosing the knowledge visualisation method the sender must take into account the receivers prior knowledge, time restrictions and preferences (Eppler and Burkhart, 2007, p.114). In addition, Eppler and Burkhart (2007, p.114) point out that the number of receivers and the setting (virtual or physical) needs to be considered. Thus in the present thesis the delivery format of reports (PowerPoint) needs to be consider when choosing the visualisations. Similarly, as it was earlier concluded the assumption of the thesis is that the deliverables are reviewed by individuals. These factors support the use of computer based visualisation methods. It also needs to be taken into account that the receivers are decision makers of Company A’s clients and that these decision makers are familiar with the industry sector which the market intelligence deliverables examine. This has an effect on how extensively the topics to be visualisad need to be explained.

Above it was concluded that many factors need to be considered when choosing visualisations. There also exists a large pool of knowledge visualisation methods one can choose from. However, as Bresciani et al. (2008a, p.1) point out good guidelines for choosing the right visualisations for a particular context run short and thus the most

suitable visualisations for a given purpose are often found by the preferences of users and by the tools available (such as PowerPoint).

For this study conceptual diagrams and visual metaphors were chosen as visualisation formats. Eppler (2006, p.205) confirms that these visualisation methods are suitable for electronic use. They can be used in the asynchronous PowerPoint format and are suitable for individual-to-individual-communication. They can also have high perceived finishedness, which indicates to the receiver that the visualisation is not open to modifications. Bresciani et al. (2008a, p.9) found out in their study that when the perceived finishedness is high, the participants are less willing to modify the visualisation. As Bresciani et al. (2008b, p.4; see also Bresciani et al. 2008a, p.5) explain, the possibility to make alterations to the visualisation should be coherent with the perception of finishedness. In Company A's reports, the possibility to change the visualisations should be seen low. Thus, the design of the visualisations needs to be well executed. However, as Bresciani et al. (2008a, p.9) point out already the medium used to present the visualisation affects perceived finishedness, and computer based media themselves add perceived finishedness.

Eppler (2006, p.205) finds conceptual diagrams and visual metaphors as instruments for knowledge communication. Eppler and Burkhart (2007, p. 1) mention conceptual diagrams and visual metaphors as core knowledge visualisation types, and present (p.119) visual metaphors as a way to utilise the brain's capacity to process images. Burkhart, (2004b, p.7) notes that decision makers use diagrams, clip arts and visual metaphors in their communication. These visualisation methods could be interpreted as preferences, which were discussed above; preferences were suggested to be one of the criteria for choosing the right visualisations. Nevertheless, it has been argued in knowledge visualisation literature that in some cases visual metaphors can be considered too playful in the business context (e.g. Eppler 2006, p.205); this argument would not support the choice of visual metaphors as one of the visualisation methods for the present thesis. However, some researchers (e.g. Kernbach and Eppler 2010, p.349) have gained positive results when using visual metaphors in the business

environment. Because of these findings and because the other suggested selection criteria presented above support the choice, visual metaphors are accepted as a visualisation method for the present study.

Conceptual diagrams were chosen as visualisation method for the present study. Eppler (2006, p.203) defines conceptual diagrams as follows: “A conceptual diagram is a systematic depiction of an abstract concept in pre-defined category boxes with specified relationships, typically based on a theory or model”. Eppler and Burkhart (2006, p. 4) describe conceptual diagrams as “schematic depictions of abstract ideas with the help of standardized shapes”. According to Eppler (2003, p.105) diagrams help conveying knowledge by showing the relationship between pieces of information. They are ideal for analysing or structuring complex topics and situations (Eppler 2006, p.203). With the help of conceptual diagrams, it is also possible to illustrate relationships and structure information, conceive abstract concepts, make complex issues more simplistic and amplify cognition (Eppler and Burkhart, 2006, p. 4; Eppler and Burkhart, 2007, p.115). Eppler (2003, p.106) presents that diagrams may be used to present both quantitative and qualitative information.

Conceptual diagrams have certain benefits. Eppler (2006, p.206) lists that they can be used in different situations without alterations; they show an overview of the topic; and they use systematic modules to structure the issue in hand. He also mentions as a benefit that with conceptual diagrams the main aspects are always addressed. Conceptual diagrams can be used in knowledge transfer (Eppler and Burkhart 2006, p. 4; see also Eppler and Burkhart, 2007, p.115).

Figure 4 gives four examples of conceptual diagrams.

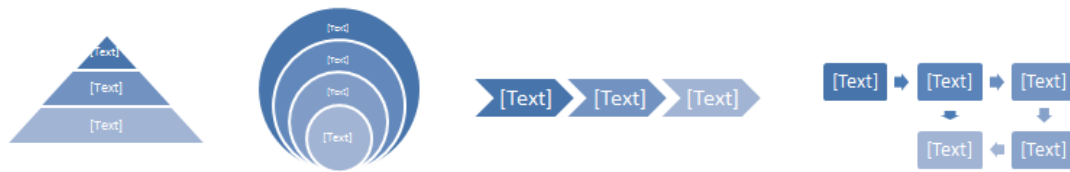


Figure 4. Examples of conceptual diagrams: Pyramid, Circle, Process and Flowchart.

Visual metaphors were chosen as the second visualisation method for the present study. Visual metaphors use visual images of phenomena, concepts or natural or artificial objects to make an association between new information and some familiar cognition (Eppler and Burkhardt, 2006, pp. 4-5; Eppler and Burkhardt, 2007, p.117). Eppler and Burkhardt (2006, p. 19) define visual metaphors as “graphic depictions of seemingly unrelated graphic shapes that are used to convey an abstract idea by relating it to a concrete phenomenon”. Visual metaphors are very instructive and they provide information rapidly as well as assist the learning process (Eppler and Burkhardt, 2006, p. 5; Eppler and Burkhardt, 2007, p.117). According to Eppler and Burkhardt (2007, p.117; see also Eppler and Burkhardt, 2006, p. 5) the “main feature [of visual metaphors] is that they organize information meaningfully”. This means that by using the key characteristics of the metaphor, visual metaphors convey implicit insights and structure information by positioning it graphically (Eppler and Burkhardt, 2006, p. 5; Eppler and Burkhardt, 2007, p.117). Furthermore, metaphors combine new information to something the receiver already knows (Kernbach and Eppler 2010, p.350). This is according to Kernbach and Eppler (2010, p.350) the key that gives visual metaphors their core competence, the reduction of order and complexity.

Visual metaphors provide some benefits. Eppler (2006, p.206) argues that they provide mental aid to memorizing, provoke attention and curiosity, bring out old knowledge about metaphors as well as assist understanding by activating functional associations. Eppler and Burkhardt (2006, p. 5; see also Eppler and Burkhardt, 2007, p.117) argue that visual metaphors can be used for knowledge transfer, and Burkhardt (2004a, p.2; see

also Eppler 2006, p.205) even concludes that visual metaphors are effective for this purpose.

It is possible to present facts, insights and relations with both knowledge visualisation methods presented above and chosen to be examined in the present study (Eppler and Burkhart, 2006, p. 1). In addition to serving as tools to present insights and relations, visualisations, including conceptual diagrams and visual metaphors, are according to Eppler and Burkhart (2007, p.113) “used as communication devices in order to trigger sense making activities and to motivate viewers to re-construct meaning”.

2.1.6. Limitations of visualisations

Similarly to other methods, knowledge visualisation has its downsides, which should not be overlooked (e.g. Eppler et al. 2006 p.36). It is the underlying assumption of the present thesis that when visualisations are used, their drawbacks should be acknowledged and that awareness of the risks might even help to minimize them. Therefore, the downsides and potential risks of using visualisations are discussed here.

Eppler and Burkhart (2006, p. 7) name five risks. Firstly, if the visualisations are not well made they can create confusion rather than understanding and thus knowledge transfer can be blocked. Secondly, too many or not enough elements may be included, hindering the receiver from capturing the idea. Thirdly, the use of unfitted or purposeless visualisation does not serve the cause. Fourthly, because visualisations are powerful tools they may mislead and manipulate the receiver into believing something that is not true. Finally, visualisations, as in fact all communication, depend on interpretation and can thus be ambiguous. According to Eppler et al. (2006 p.36) ambiguity and misunderstanding are problems especially when the visualisation is not explained well enough (verbally). Ironically, misinterpretation and misuse of information are also among the managerial problems that knowledge visualisation is trying to reduce with the help of visualisations (Burkhard 2004a, p.1). It could be

concluded that visualisations might work both ways. Thus they need to be used with care. From the argument of Eppler et al. (2006 p.36) presented above it can be concluded that the explanation of the visualisation plays an important role in whether the visualisation will turn against itself.

Eppler, Mengis and Bresciani, (2008 p.391) explain that while ambiguity can lead to misunderstandings and multiple interpretations it may also be seen in a positive light. Eppler et al. (2008) state that in collaborative work visual ambiguity can be seen as value adding and something worth striving for as it can e.g. facilitate discovering and generate new insights. This can be beneficial especially in knowledge creation. However, these advantages are not considered in the present thesis which studies knowledge transfer. In Company A's deliverables, where knowledge needs to be transferred so that decision makers can base their decisions on it, ambiguity can have negative effects and thus needs to be avoided. Eppler et al. (2008 p.393) argue that ambiguity may be reduced by providing text which can direct the interpretation of the visualisation.

Eppler et al. (2006 p.36) add that an ineffective use of visualisations may lead to an illusion of understanding. This risk could be regarded as one of the most serious ones, especially among decision makers. It is less harmful not to understand the message communicated through a visualisation, than to make decisions based on false beliefs of understanding.

Ware (2007p. 27) brings out an interesting point that requires attention when the shortcomings of visualisations are considered. He argues that people construct the impression of their environment with rapid eye movements. What we see is the result of what we are trying to see, he claims. If we, for example, are trying to find lost keys we focus on the objects on the ground, if we are trying to find a way through a crowd we see the path. Based on Ware's arguments the present thesis reasons that visualisations might be misunderstood if the persons interpreting visualisation have presumptions of the subject, if they for example are looking for a justification for their decision.

There are certain disadvantages that need to be considered especially when using visual metaphors. Indeed, Eppler (2006, p.205, 206) mentions various drawbacks of visual metaphors. He argues that in a certain context they may be seen unsuitable, for example too playful, as mentioned above. Secondly, attention might be shifted from the content to the visualisation itself. This might for instance happen in a situation where the visualisation is very well made and possesses some artistic value. Thirdly, if used often, visualisations might lose their advantage. Eppler (2006) continues that visual metaphors can also be manipulative, be misunderstood and they can make things that are fundamentally different seem common. It is understood in the present study that decision makers may indeed consider the metaphors too playful for their reports. In addition, as strategic decisions need to be made leaning on reports one needs to be extra cautious to avoid manipulation and presenting commonalities that does not exist.

Eppler (2006, p.206) lists disadvantages also for conceptual diagrams. They might be difficult to understand or diagrams may not be suitable tools to present the topic. According to Eppler (2006) conceptual diagrams do not provide mental aid to memorizing. Eppler (2006) mentions one additional drawback of conceptual diagrams, i.e. they do not encourage creativity. This is not further discussed here as the present thesis focuses solely on knowledge transfer, not for example on knowledge creation.

As discussed above visualisations have many possible drawbacks. Eppler and Burkhart (2006, p. 7) emphasise that these risks of using visualisations should always be kept in mind. For instance, to prevent ambiguity and a false sense of understanding, one should offer text to support complex visualisations. The use of descriptive headlines could for example guide the attention to the details necessary for understanding the message of the visualisation. Nonetheless, because the present thesis seeks to focus on studying solely the impact of visualisations and the reactions in particular towards visualisations, supporting text is not provided for the visualisations to be examined.

2.2. Theoretical framework

This section forms the theoretical framework for the present study by combining the arguments of knowledge visualisation discussed in the literature review above to a simplified model of Shannon's (1948) traditional communication theory.

In traditional communication theories a communication process has been understood as a message transfer from a message sender to a message receiver through a message channel. Figure 5 presents Shannon's (1948, p.7) communication system first published in "A Mathematical Theory of Communication" in 1948.

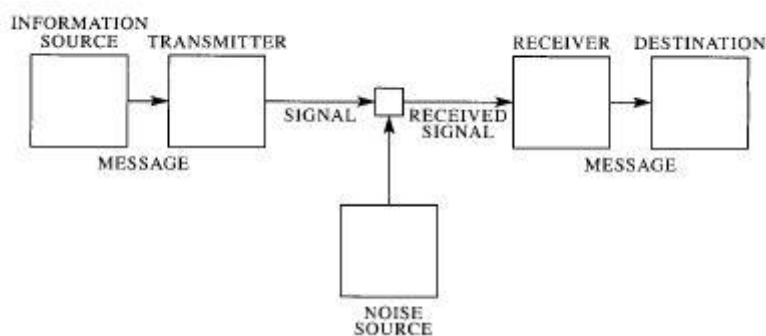


Figure 5. Shannon's schematic diagram of a general communication system (Shannon 1948, p.7).

In Shannon's (p.6-7) schematic diagram of a general communication system the information source creates a message and the transmitter changes the message into signals that the used channel is able to transmit. The channel is just the medium that is used to carry the signals to the receiving terminal. The receiving terminal (in Figure 5 marked as a receiver) reconstructs the signals back to the message. The destination in Shannon's diagram illustrates the person for whom the message was sent.

Shannon (1948) created his communication diagram to illustrate a communication situation where most often the message needs to be transferred into signals and

recreated at the receiver's end to a message. A good example of this is the use of telegraphy. Thus, the transmitter is merely a device that turns a message into signals and the receiver is merely a device that reconstructs the message to a destination.

Shannon's model has been widely criticised (e.g. Pauly 1977; Cherry 1966). The simplicity of the model and the way it presents the communication as one-way action as well as how it treats the recipient as a passive actor, have attracted criticism. Shannon's model has also received criticism because it neglects human interaction (see e.g. Pauly 1977; Bowman and Targowski 1987). However, initially Shannon's theory was developed as a model explaining electronic transmission of data and was later adopted in general service "because of its seeming simplicity and its foundation in scientific principle" (Bowman and Targowski 1987, p.23).

Even though Shannon's theory has received criticism, it has been widely used. It seems that this is mainly because alternative models that would have been widely accepted have not really appeared. Bowman and Targowski (1987, p.25) argue that "in spite of the seeming deficiencies of the mathematical model, it has remained the most enduring conception of the communication process. Alternative paradigms have generally been more complex and more difficult to understand". It is the understanding of the present author that Shannon's model has been an inspiration to many communication scientists, not least because the model, in its simplicity, is open to alterations. For example, Campbell and Level (1985) and Herbert (1977) have presented their own interpretations of the communication model. It is the underlying assumption in the present thesis that Shannon's traditional communication diagram can be also adjusted to describe a knowledge transfer process.

The use of technology in a communication process creates a link between Shannon's model and the present thesis. Shannon was interested in communication with the aid of technology and his theory seems to work best when it is assumed that there is something more than thin air between the communicators. The present study does not examine

face-to-face communication but communication through an electronic (PowerPoint) format.

One-way direction in communication in Shannon’s model does not present a problem for the present thesis as Company A’s consultants only communicate their knowledge to decision makers through an electronic document. Thus no two-way interaction is created between the sender and the receiver in the communication situation examined in the present thesis. Nevertheless, in the present study, the receiver can, by no means, be seen as passive. This is one of the reasons why the model needs alteration and may only be used as a back bone of the theoretical framework of the present study.

In the present thesis the components of ‘transmitter’ and ‘receiver’ have been simplified into a single term ‘channel’. While it can be assumed that Shannon referred mainly to e.g. technical suppress noise when creating his model, the ‘noise’ can be anything distracting the transfer of message. Cherry (1966, p.42) defines the noise as “any disturbance or interference, apart from the wanted signal or message selected and being sent”. These kinds of distractions occur in all circumstances. In the present thesis the source of noise has been left out to simplify the model even further. It is, however, the assumption of the present thesis that noise can occur at any state of the knowledge transfer process. Figure 6 presents the simplified diagram of a communication system.



Figure 6. Simplified diagram of a communication system.

Shannon (1948) calls the person to whom the message is sent to 'destination'. In the present thesis this destination will be referred to as a receiver. Shannon's information source will be called a sender. Earlier we learned that in knowledge transfer knowledge needs to be recreated in the mind of the receiver (e.g. Eppler and Burkhart 2006, p. 2; Alavi and Leidner 2001, p.120; Gururajan V. and Gardiner M. 2004, p.2). Thus the receiver cannot be seen as a passive recipient of the message. It was also earlier presented that the message sender conveys the message he wants to communicate (e.g. Eppler and Burkhart 2006, p. 2; El Sawy et al. 1997, p.11). Therefore the message is not actually sent and received but conveyed and recreated. In the present thesis this *message* is *knowledge* that needs to be transferred from the sender to the receiver. Thus in the framework of the present thesis the word 'message' is replaced with the word 'knowledge'. In the present study the channel is the actual tool of communication that carries the conveyed knowledge to the receiver who recreates the knowledge in his own mind.

Earlier it was argued that knowledge transfer can be done through visual metaphors and conceptual diagrams (e.g. Eppler and Burkhart 2006, p. 4, 5). The present thesis uses these visualisation methods in an electronic form. Thus the channel can be seen in the present research design as either a visual metaphor or a conceptual diagram in an electronic form.

The theoretical framework of the present thesis combines Shannon's (1948) schematic diagram of a general communication system and the principles of knowledge transfer. The theoretical framework of the present study is illustrated in Figure 7.

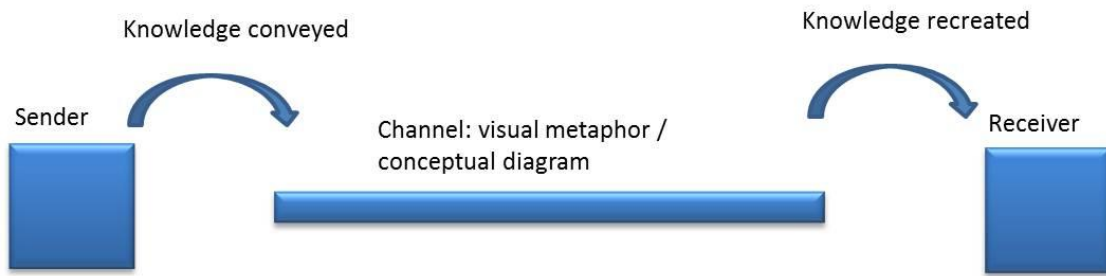


Figure 7. Theoretical framework of the present study.

Figure 7 shows that the sender conveys the knowledge which is transmitted to the receiver through either a visual metaphor or a conceptual diagram. The receiver needs to recreate the knowledge in his own mind. However, as presented earlier, the cognitive capacity (e.g. Eppler and Burkhardt 2006) as well as the private and cultural models (Ringberg & Reihlen 2008) affect the success of the transfer through recreation of the knowledge. The knowledge might not reach the receiver or it might reach the receiver only partly. Similarly, the knowledge that reaches the receiver might not be the same knowledge the sender intended to communicate. It is the understanding of the present thesis that private and cultural models also affect the sender's ability to convey the message. This has been illustrated in Figure 8.

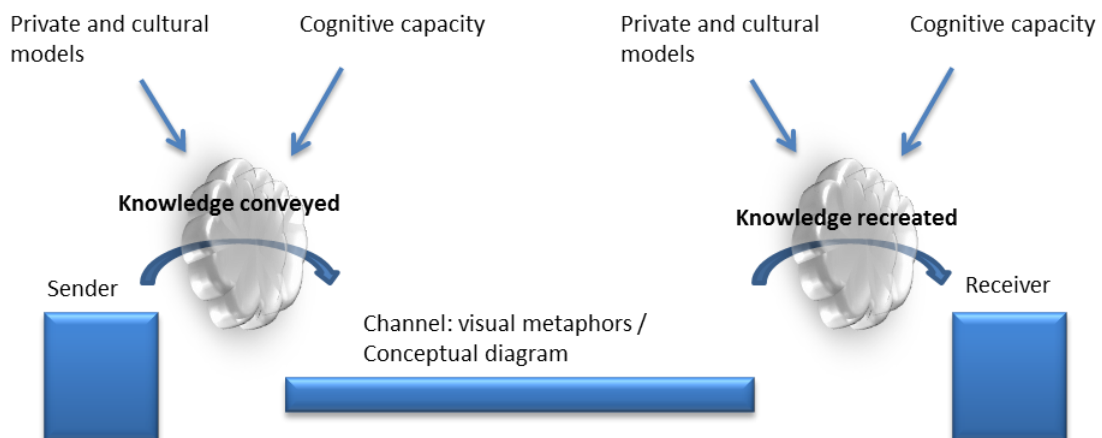


Figure 8. Modified theoretical framework of the present study.

3 METHODS AND DATA

This Chapter introduces the methods used in the present study in order to find answers to the research questions presented. In the first section of this chapter the method of a single-case study is discussed, the survey process is described in detail and the sample structure and data analysis methods are presented. The second section discusses the trustworthiness of the study through validity and reliability.

3.1. Methods and Data

This section presents the methods used to study the topic of the present thesis as well as introduces the data of the study. According to Yin (2009, p. 18) a case study is “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real life context especially when the boundaries between the phenomenon and context are not clearly evident”. In addition to the traditional application areas, ethnography and anthropology, case studies have been used for example in economic science (Laitinen 1998, p.17). The research method of case studies is not always highly valued and it has received criticism, but at the same time, however, case studies are commonly used (Flyvbjerg, 2011, 302). Case study research can be conducted through single- or multiple-case studies, notes Yin (2003, p.14). The following subsection justifies the use of a single-case study design in the present thesis.

3.1.1. Single-case study

A single case design was chosen for the present thesis. The choice of this methodology rises from a need, as Company A requested a study on knowledge transfer with visualisations among their clients. As the need for this study comes directly from Company A, it was naturally selected as the case company of the present thesis. Accordingly, a case study as a research design is a natural choice. Furthermore, as

mentioned earlier, knowledge visualisation still remains as an emerging field and in preliminary investigation case studies are often used (e.g. Flyvbjerg, 2011). Mistakenly it has sometimes been understood that because case studies are often used in the preliminary stages of the study, it would simply be a tool to get the ‘real’ investigation started (Flyvbjerg, 2011). However, as Laitinen (1998, p.49) argues case study is not just a tool for the ‘main study’, but it can be used as an independent research design. Besides, some problems can be studied only with the case study, because they are, in fact, cases (Laitinen 1998, p.49). Thus, the present thesis examines the case of Company A. These arguments further justify the use of single-case study design. Moreover, as Yin (2003, p.40) claims, “the single case study can represent a significant contribution to knowledge and theory building”.

Above it was argued that a single-case study is a valid research design for the present thesis. Next, it is further explained why the present study can be conducted through a case study. Laitinen (1998, p.20) argues that case studies are suitable for all studies where the subject of study can be delineated either categorically or functionally. Categorical delimitation means that the subject presents some physical unit or units in the real world. Functional delimitation, in turn, means that a functional process or event can be separated as a subject of the study. Both of these delimitations can be understood to apply to the present study. Company A itself can be seen as a physical unit. The subject of the study has been further defined as the Finnish customers of Company A. On the other hand generating deliverables to clients can be seen as a functional process of Company A. Thus it can be confirmed that a case study is a suitable method for the present thesis.

Case studies can include both quantitative and qualitative evidence, and moreover it is also possible that they include merely quantitative evidence (Yin 2003, p.14, 15). Yin also notes that a case study does not equal qualitative research. Observation or other qualitative research methods do not have to be included in all case studies (Yin 2009, p.19). Laitinen (1998, p.17) explains the relevance of each type of evidence: when the process itself is studied, a qualitative approach is most relevant; but when the study

focuses on the resources of the process or when it estimates the effectiveness of the end result, quantitative methods may be used. This is relevant for the present study as the aim of the present thesis is to see if the intended knowledge can effectively be transferred to Company A's clients as an end result of the communication process through deliverables.

3.1.2. Data collection and question design

This section first describes the process of data collection through a survey questionnaire and then outlines the question design. Quantitative internet administrated surveys were conducted to answer the research questions of the present study.

Two separate online surveys were designed by using an online questionnaire tool. One of the surveys contained conceptual diagrams (Appendix 1), the other one visual metaphors (Appendix 2). (Appendices 3 and 4 offer the English translations for surveys.) However, both of the surveys had exactly the same questions, only the visualisation methods were different. The visual metaphor survey had four different metaphors, which all displayed a different matter. These four different matters were displayed in the conceptual diagram survey with conceptual diagrams. In other words, the present study had four different matters that were each visualised with both a visual metaphor and a conceptual diagram. The questionnaires were provided in Finnish. All survey respondents were speakers of Finnish.

The visualisations were chosen for the surveys with a two-step selection process. First, the conceptual diagrams were chosen from Company A's reports by the present author and Product Management Director. The criterion for selection was that the conceptual diagrams selected should not resemble one another. All the selected conceptual diagrams were often used in Company A's reports. Second, the same matters that were presented with the conceptual diagrams were visualised with visual metaphors by the present author. According to the best understanding, he present author chose the most

suitable visual metaphors to convey the message. Three out of four visual metaphors were created with Let's Focus software. One of the visual metaphors was created simply by adding text on top of a picture. Only four visualisations were chosen for each survey to keep the surveys short enough, so that the respondents would answer all the questions.

In the first survey page of each survey the respondents were requested to fill in demographic data. These questions were presented in order to find out the descriptive demographic statistics of the respondents. This was also to make sure that all respondents belong to the target group i.e. are decision makers of the company. To rule out the respondents that were not in the target group, a question about taking part in strategic or operational decision making in the company was presented among the demographic questions. If the respondents' answer revealed that they were not taking part in either strategic or operational decision making, the survey moved automatically to the final 'thank you'-page.

In the introduction section of each survey, the respondents were given instructions for answering the survey. They were told to first study the visualisation and then respond to the questions presented. It was told to the respondents that the survey does not test their knowledge of the matter, but rather how the message comes across from the visualisation. The respondents were instructed to answer the questions after their own interpretation of the visualisation. It was acknowledged that by giving these instructions to the respondents, the purpose of the study was revealed to the subjects. However, it was necessary to instruct them to answer based on the visualisations as otherwise the respondents could have answered based on their previous knowledge. At that point the survey would not have examined whether the knowledge can be transferred through the visualisation.

In both surveys, after the demographic features and introduction section, four different visualisations (visual metaphors in one survey, conceptual diagrams in the other) were presented with questions. Each visualisation with its questions was presented on a

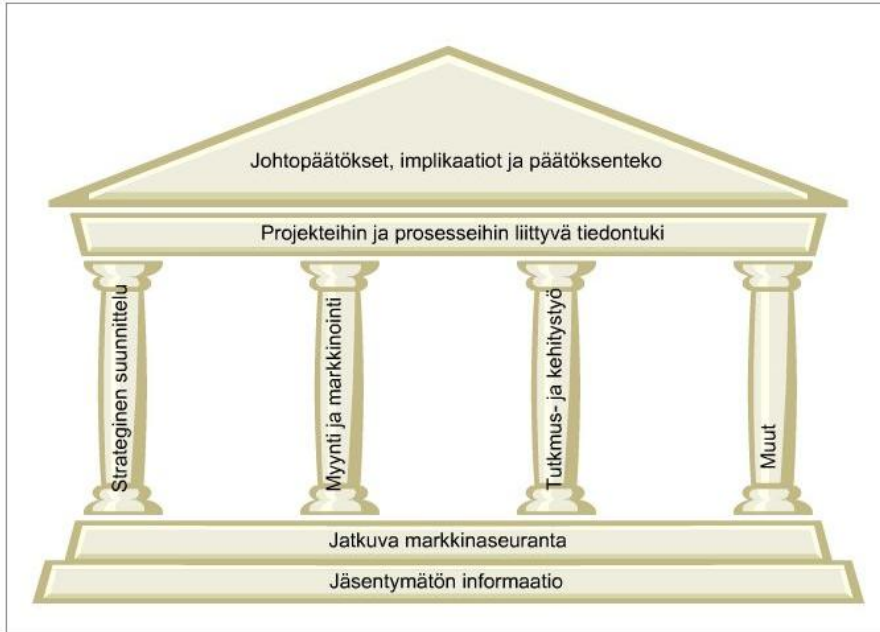
separate page. In the beginning of each page the respondents were instructed to answer the questions based on their own interpretation of the visualisation. All visualisations had the same set of questions. The questions were simple yeas-or-no questions.

Questions 1, 3 and 4 were exactly the same in all visualisations and both surveys. (See Appendices 1–4) The purpose of question 1 was to investigate if the respondents, in their own opinion, understood the message of the visualisation. Question 3 inquired if the respondent thought, that particular kind of visualisations would be appropriate in reports generated for their company. Question 4 examined if the respondents thought that the visualisation would require text to support understanding. Question 2 was specifically designed to the matter at hand and it provided two different claims about the visualisation. Thus, the visual metaphor in one survey and the conceptual diagram in the other, visualising the same matter, had the same question 2. The purpose of question 2 was to find out whether the respondent understood the message of the visualisation. Thus it was possible to answer either correctly or incorrectly to each claim. These claims were carefully considered together with the Product Management Director of Company A and at that stage it was also decided what the correct answer for each claim would be. Efforts were made to generate claims that would only have one possible correct answer. An example of the survey page is given in Figure 9.

Kysely visuaalisista metaforista tiedon kommunikoinnissa

Sivu 3

Vastaa kysymyksiin visualisoinnin perusteella, oman tulkintasi mukaan.



1. Ymmärrän viestin, joka tällä visualisoinnilla halutaan välittää

- Kyllä
 Ei

2. Tämä visualisointi viestittää, että

a. jatkuva markkinaseuranta rakentuu jäsentymättömän tiedon varaan

- Kyllä
 Ei

b. johtopäätökset, implikaatiot ja päätöksenteko koostuvat muista sen alla esitetyistä toiminnoista

- Kyllä
 Ei

3. Sopisivatko tämän tyyliiset visualisoinnit yrityksellenne tuottettuihin raportteihin?

- Kyllä
 Ei

4. Visualisointi tarvitsisi tekstiä ymmärtämisen tueksi

- Kyllä
 Ei

Jatka myöhemmin

Jatka >



50 %

Figure 9. Example of a survey page. (See Appendix 4 for the English translation.)

Before distributing the survey to the sample group, a test group tested the survey and alterations were made based on their review. These alterations mainly concerned the instructions given to the respondents. The test group consisted of Company A's employees and some personal contacts of the present author. These personal contacts were working in different fields.

In Company A the sales people manage relations with clients. Hence, the sales people of Company A contacted some of their contact clients by phone and asked if the client company was willing to participate in the survey. It was under the sales people's control which of their client companies were contacted. This was to ensure that no client relationships were disturbed with a survey participation request. The links to the online surveys were distributed to the contact persons of the client companies of Company A that were willing to participate. All the companies that accepted the invitation were listed and the recipients of the two different surveys were randomly selected. This way, different visualisation methods were tested with different respondents. As both visual metaphors and conceptual diagrams displayed the same matter, it would have caused errors in measurement, if the same people would have answered both surveys. For example, the matter would not have been new for the person studying the conceptual diagram if he had already answered the survey of visual metaphors. Thus, the respondent's answers to the questions in the conceptual diagram survey would not have been based only on the understanding of conceptual diagrams but rather the combination of the conceptual diagrams and the prior knowledge from the visual metaphors.

The contact persons at the client companies were instructed to distribute the cover letter (Appendix 5; the English translation of the cover letter, Appendix 6) with a survey link via email to the strategic or operational decision makers of their company. These decision makers could be any representative of managers or directors. The contact persons were used as the point of contact to the client companies because they had a wider knowledge of who in their company belong to the target group of the survey. It

was also considered that the subjects might be more willing to answer the survey if the request would come from inside their company.

3.1.3. Sample structure

This section describes the demographics of the respondents and illustrates what kind of companies took part in the surveys.

The conceptual diagram survey was distributed to five companies. The companies are operating in the fields of construction, transportation, financial services as well as manufacturing and solutions. The visual metaphors survey was also distributed to five companies. The companies are operating in the fields of e-solutions, telecommunications, marketing and consulting as well as construction and manufacturing. In addition, there was one public organisation among the companies in both of the surveys. The word *companies* refers also to these two organisations when the results of the present study are presented and discussed. All the participating companies differ from each other regarding the operating field.

The conceptual diagrams survey was distributed to a total of 31 respondents and the visual metaphors survey to 26 respondents. The conceptual diagram survey received 15 answers, thus the respondent rate was 48.4 %. The visual metaphors survey received 16 answers, the respondent rate was 61.5 %. However, as the companies taking part in the survey had already announced their willingness to take part, and as the survey link was distributed internally in the companies, the response rate was expected to be fairly high in comparison to surveys in general. Table 1 presents the demographics of respondents for both surveys.

<i>Question</i>	Conceptual Diagrams		Visual Metaphors	
Age				
Answer	Count	Percent	Count	Percent
under 24	0	0,00 %	0	0,00 %
25-30	1	6,67 %	1	6,25 %
31-40	7	46,67 %	4	25,00 %
41-50	7	46,67 %	6	37,50 %
over 51	0	0,00 %	5	31,25 %
Gender				
Answer	Count	Percent	Count	Percent
Female	7	46,67 %	9	56,25 %
Male	8	53,33 %	7	43,75 %
Position in the company				
Answer	Count	Percent	Count	Percent
Employee	0	0,00 %	0	0,00 %
Expert	7	46,67 %	6	37,50 %
Manager	2	13,33 %	3	18,75 %
Director	6	40,00 %	7	43,75 %
I take part in strategic decision making in my company				
Answer	Count	Percent	Count	Percent
Never	3	20,00 %	1	6,25 %
Sometimes	5	33,33 %	9	56,25 %
Often	7	46,67 %	6	37,50 %

Table 1. Demographic features of the respondents.

In the conceptual diagrams survey seven out of the 15 respondents were female, eight were men. Seven of the respondents were in the age group of 31–40 and seven were in the age group of 41–50. Only one of the respondent belonged to the age group of 25–30. None of the respondents were either 24 or under. Similarly none of the respondents were 51 or over. In the visual metaphors survey nine out of 16 respondents were female, seven were men. Four respondents were in the age group of 31–40, six were in the age group of 41–50 and five of the respondents were 51 or over. One of the respondents belonged to the age group of 25–30, none were 24 or under. On average the respondents of the visual metaphor survey were older than the respondents of conceptual diagram

survey. In the conceptual diagrams survey female respondents were older than male respondents while in the visual metaphors survey male respondents were older than female respondents. Gender distribution in both surveys was rather even. Table 2 presents the age distribution by gender for both surveys. Table 2 also displays how the distributions would look like if the respondents who were not taking part in the strategic or operational decision making would have been subtracted from the total sum.

Visual metaphors		
	Female	Male
under 24	0	0
25-30	1	0
31-40	4(3)	0
41-50	2	4
over 51	2	3

Conceptual diagrams		
	Female	Male
under 24	0	0
25-30	0	1
31-40	3(1)	4(3)
41-50	4	3
over 51	0	0

Table 2. Age distribution by gender. Respondents who were not taking part in strategic or operational decision making have been subtracted from the total sum presented in parentheses.

In the conceptual diagram survey seven respondents worked as an Expert, two worked as a Manager and six as a Director. In the visual metaphors survey six respondents worked as an expert, three worked as a manager and seven as a director. The demographic feature of how respondents are positioned in the company is relatively similar in the two surveys. In the conceptual diagram survey seven out of 15 respondents informed that they often take part in strategic or operational decision

making in their company. Five respondents announced that they take sometimes part in strategic or operational decision making. In the visual metaphors survey the corresponding figures were nine and six out of 16 respondents. In the conceptual diagrams survey three and in the visual metaphors survey 1 reported that they never take part in strategic or operational decision making. These respondents did not continue the survey further. Thus, a total of 12 respondents completed the conceptual diagram survey and 15 the visual metaphors survey. In the remaining survey answers these figures were considered as the total number of respondents. There was no missing data as all respondents answered all the questions.

3.1.4. Data analysis

In this section the process of analysing the data gathered with an online survey is briefly discussed. The surveys used to study the research questions provided quantitative data. The data analysis focuses on counting occurrences and presenting them as percentages and averages.

The data was pulled out from the online questionnaire tool to an Excel sheet. This data was already coded into countable units, and a table was created out of the responses. Given the size of the data no further grouping was needed. The results were sorted according to a variety of criteria to get the results to specific questions. Once sorted, the occurrences were counted manually. The averages were counted using arithmetic means. Some of the quantities expressed as percentages were generated by the survey tool, others were calculated by the present author.

3.2. Trustworthiness of the study

In this section the trustworthiness of the study is discussed from the perspective of validity and reliability. "Validity is the degree to which the instrument measures what it

is intended to measure (Wrench, Thomas-Maddson, Richmond, and McCroskey 2008, p202)” and “reliability refers to the consistency of a measure of a concept (Bryman and Bell 2003, p.76)”. These criteria are discussed next especially from the case study point of view.

3.2.1. Validity

As mentioned above validity defines if the selected method of measurement measures what it is supposed to measure. Groves, Fowler, Couper, Lepkowski, Singer and Tourangeau (2009, p.51) argue that “validity is the correlation of the measurement, and the true value.” Both Yin (2003) and Laitinen (1998) divide validity into three kinds: construct validity, internal validity and external validity.

Construct validity refers to the source of evidence. It is sought by using multiple sources of evidence or by reporting all the phases of a study in a way that the study process can be followed by a report reader. In other words the chain of evidence needs to be established. (e.g. Yin 2003; Laitinen 1998.) The present study has aimed to create the chain of evidence by describing the survey process earlier in this chapter and offering the survey material as appendices. When discussing the results in Chapter 5, other factors possibly affecting the survey results have been considered. An alternative way to ensure construct validity, according to Yin (2003, p.34), would be having the key informants to review the draft case study report. However, the present study relies on the chain of evidence in attempts to ensure the construct validity.

Internal validity considers if causality can be found and whether causality is the correct one i.e. if X is a result from event Y or rather from a third factor Z. Thus, the main question is whether the conclusion is entitled. (e.g. Yin 2003; Laitinen 1998.) While Yin (2003, p. 34) identifies four different tactics to achieve internal validity: pattern-matching, explanation-building, addressing rival explanations and using logic models,

he continues by arguing that this logic is not applicable to exploratory studies in which causal claims are not the main focus.

External validity on the other hand measures if the results of a case study are generalizable and do not merely reflect a specific case (e.g. Yin 2003; Laitinen 1998). This is a validity problem that has been used in criticism against case studies (Yin 2003, p.37). To better ensure external validity in single-case studies Yin (2003, p.34) suggests the use of theory. However, as the present thesis studies an emerging field, no applicable theory exists. This is why external validity cannot be reached in the way Yin suggests. Nevertheless, preliminary studies are needed in an emerging field. Laitinen (1998, p.67-70) presents another approach. She argues that external validity can be divided into comparability and transferability. Laitinen (1998) explains that comparability measures to what extent the different parts of study and the key concepts have been described and defined. This gives other researchers an opportunity to compare the study results to other studies dealing with similar research issues. According to Laitinen (1998) transferability measures how well the researcher uses the concepts, definitions and research techniques of the field. This way the results could be applicable in another setting, she argues. The present study has strived for using the terminology of the knowledge visualisation field as well as explaining them in depth. While this approach has been carried out throughout the study, the most thorough explanation of the concepts is mostly offered in the literature review chapter. Moreover, the present author is well informed of the practicalities and topics relevant for the business area of Company A.

Laitinen (1998) also acknowledges that generalizability is a central issue in case studies. She (1998, p.68) argues that in quantitative research generalizability is not in fact the same as statistical probability but rather how well the person applying the results is able to use them. This understanding has been adopted to the present study.

As discussed earlier Groves et al. (2009, p.51) argue that validity reflects the correlation between the measurement and the true value. Nevertheless, it is acknowledged in the

present study that when studying knowledge transfer, the true success of transfer can never be revealed as knowledge is something people possess in their minds and it cannot be measured exhaustively.

3.2.2. Reliability

Wrench et al. (2008, p.188) define reliability as follows: “the accuracy that a measure has in producing stable, consistent measurements [...] so ultimately reliability is about making sure our tools for measuring a phenomenon are accurate”. Consequently, the question is about the ability of the measurement to produce consistent results. This means that if the same case study was conducted again, the results would not change (e.g. Yin 2003, Laitinen 1998). Wrench et al. (2008, p.188) note that when humans are studied, the continuous replication of measurements is not obviously possible. Thus reliability has to be estimated and cannot be known precisely, they argue. Reliability also affects the validity: if the measure is not reliable it cannot be valid either (Bryman and Bell 2003, p.79).

Both Yin (2003) and Laitinen (1998) encourage researchers to use case study protocols to increase reliability. Yin (2003 p.9) lists the following issues to be covered in a study protocol: overview of the project, procedures in the field, research questions and a guide to the case study report. A general outline of these issues was conducted prior to the present study in the form of a research plan. The present study did not use observation or other methods that would have required the specification of field procedures but the survey procedures were planned and carefully explained. Additionally, Laitinen (1998, p.71) suggests the use of a chain of evidence to increase reliability. As already mentioned above, the present study has tried to implement this as thoroughly as possible.

Bryman and Bell (2003, p.76) bring out an interesting dimension of reliability: stability. This means that the measure is stable over time. It is important to note that since the

present thesis is studying the reactions of people towards visualisations methods, the results might not be consistent through time. It is good to understand that attitudes and views may change. Moreover, if people would get more experienced in reading visual representations their confidence towards visualisations might shift. More exposure to visualisations might also affect the possibility of transfer of knowledge; if people are trained to interpret visualisations, they might more easily understand the messages communicated through them.

The dimensions of reliability and validity were discussed in this section. It is good to acknowledge that the emerging field of study and the single-case design, as well as using only quantitative surveys as the research method present certain reliability and validity limitations to the present thesis. Therefore, to increase the transparency of the study, a detailed description of the survey process has been given in this chapter and other issues possibly affecting the survey findings are discussed in Chapter 5.

4 FINDINGS

The findings of the two visualisation method surveys are presented in this chapter. The purpose of the present thesis was to discover the reactions of Company A's clients' decision makers to visualisations methods. Two different visualisation methods, conceptual diagrams and visual metaphors, were tested in two separate online surveys. The findings present answers to the following research questions:

- 1 A. Could conceptual diagrams be used for knowledge transfer to Company A's customers' decision makers?
- 1 B. Could visual metaphors be used for knowledge transfer to Company A's customers' decision makers?

Next, the findings of the survey are reviewed first separately by each matter represented with a conceptual diagram and a visual metaphor, then by average figures. Hence, it is important to note that the headlines indicating the subject of visualisations were not presented to the respondents in the survey questionnaire. The questionnaires were written in Finnish and all the translations for this this report are by the present author.

4.1. Matter 1: Market Intelligence functions supporting decision making

The first Matter presented with a visualisation in the two surveys described how different Market Intelligence functions support decision making. In the conceptual diagram survey Figure 10 and related questions were presented. (Note the Finnish version used in the survey can be found in Appendix 1.)

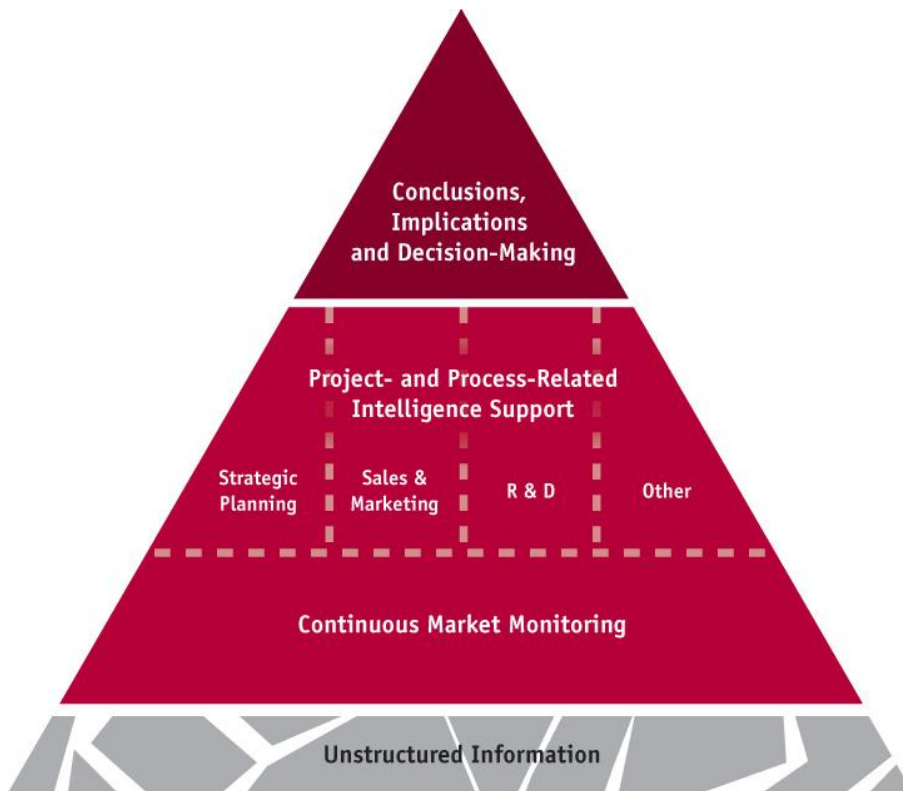


Figure 10. Conceptual diagram 1. Market Intelligence functions supporting decision making.

A total of 92% (11 respondents out of 12) of the respondents indicated that they understand the message that has been signalled through this conceptual diagram. (All the results have been rounded up to the nearest integer) However, only one person (8%) out of the 12 respondents offered correct answers to both claims about the visualisation and 33% of the respondents answered correctly to one of the two claims. The claims with the correct answers are presented in Table 3 below. On the other hand 67% did indicate that the visualisation in question would need text to support understanding. All 100% of the respondents agreed that these kinds of visualisations would be suitable for the reports generated to their company.

In the visual metaphors survey Figure 11 and related questions were presented. (Note the Finnish version used in the survey can be found in Appendix 2.)

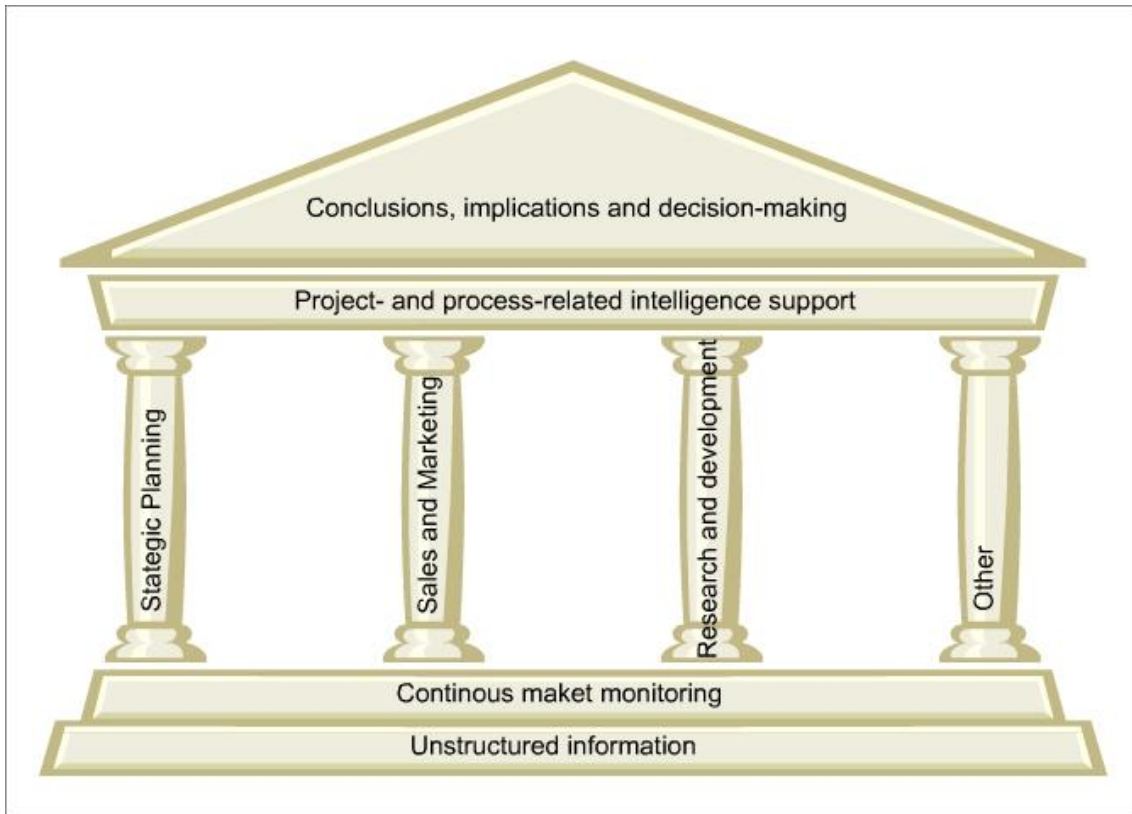


Figure 11. Visual metaphor 1. Market Intelligence functions supporting decision making.

60% (9 respondents out of 15) of the respondents indicated that they understand the message that has been signalled through this visual metaphor. Nevertheless, only one person (7%) of all the 15 respondents offered correct answers to both claims about the visualisation and 30% of the respondents offered correct answer to one of the two claims. The claims with the correct answers are presented in Table 3 below. 67% indicated that the visualisation in question would need text to support understanding. 40% considered this kind of visualisations suitable for the reports generated to their company. While 57% of the male respondents found these kinds of visualisations suitable, only 25% of the female respondents agreed.

Table 3 summarizes the responses for questions 1 and 2 regarding Matter 1 in both surveys.

Matter 1: Market Intelligence functions supporting decision making							
Conceptual diagrams				Visual metaphors			
1. I understand the message that has been signalled through this visualisation.				1. I understand the message that has been signalled through this visualisation.			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	11	91,67 %	1	Yes	9	60,00 %
2	No	1	8,33 %	2	No	6	40,00 %
	Total	12	100 %		Total	15	100 %
2. This visualisation signals that				2. This visualisation signals that			
a. continuous market monitoring is based on unstructured information				a. continuous market monitoring is based on unstructured information			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	6	50,00 %	1	Yes	5	33,33 %
2	No	6	50,00 %	2	No	10	66,67 %
	Total	12	100 %		Total	15	100 %
b. conclusions, implications and decision-making are composed of the other functions presented under it				b. conclusions, implications and decision-making are composed of the other functions presented under it			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	10	83,33 %	1	Yes	11	73,33 %
2	No	2	16,67 %	2	No	4	26,67 %
	Total	12	100 %		Total	15	100 %

Table 3. Answers for questions 1 and 2 in Matter 1. The correct answers for question 2 are bolded.

4.2. Matter 2: Development levels of Market Intelligence function

The second Matter that was presented with visualisations in the surveys described the development levels of the Market Intelligence function. In the conceptual diagram survey Figure 12 and related questions were presented. (Note the Finnish version used in the survey can be found in Appendix 1.)

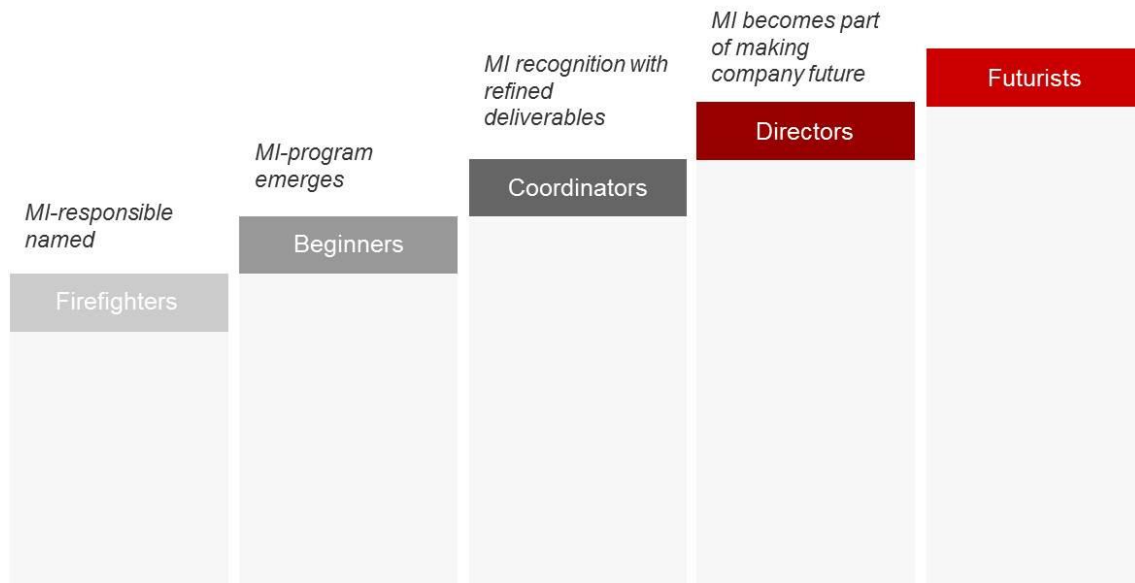


Figure 12. Conceptual diagram 2. Development levels of the Market Intelligence function.

A total of 83% (10 respondents out of 12) of the respondents reported that they understand the message signalled through this conceptual diagram and 42% of the respondents offered correct answers to both claims. Yet, 58% said that text to support understanding would be needed. 67% of the respondents offered correct answer to one claim. The claims are presented in Table 4 below. 83% found these kinds of visualisations suitable for the reports that are generated to their company. More women (100%) than men (71%) found these kinds of visualisations suitable for their company reports.

In the visual metaphors survey Figure 13 and related questions were presented. (Note the Finnish version used in the survey can be found in Appendix 2.)

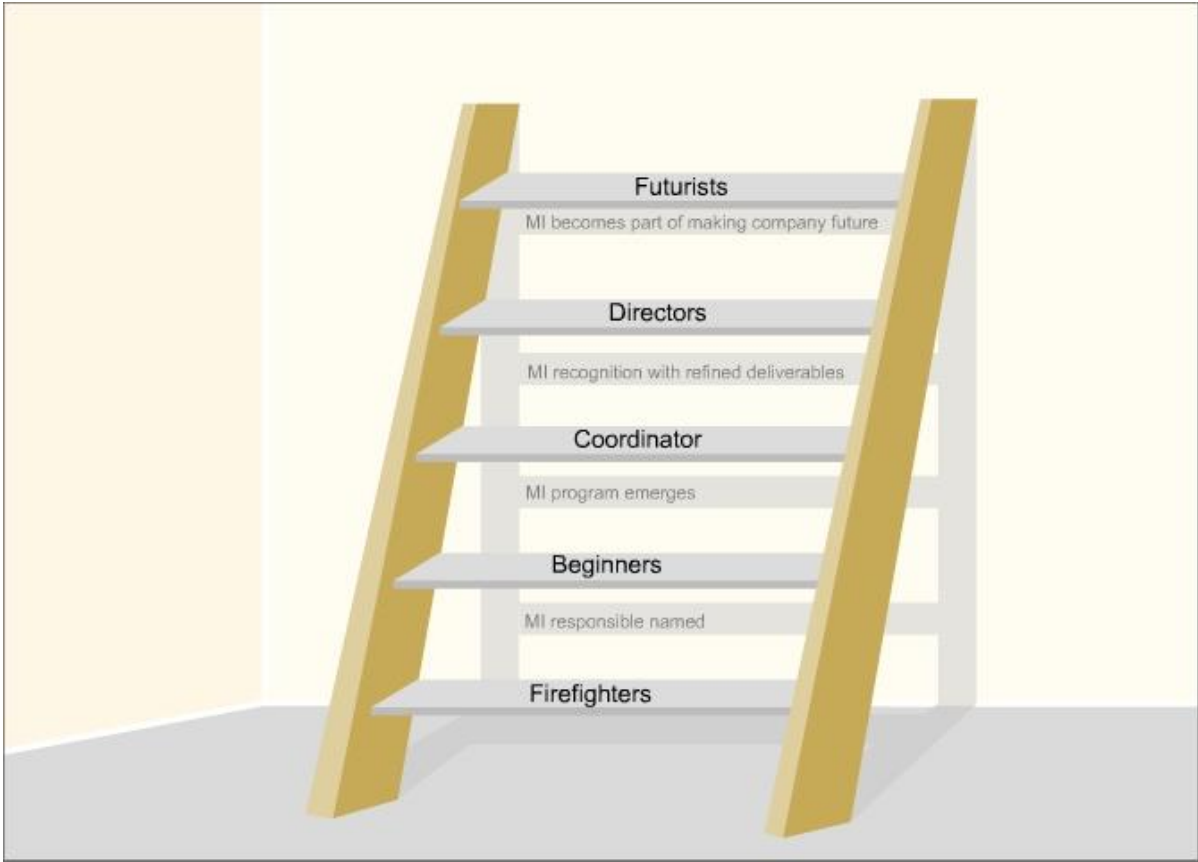


Figure 13. Visual metaphor 2. Development levels of the Market Intelligence function.

73% (11 respondents out of 15) said that they understand the message that has been signalled through this visual metaphor. 40% of the respondents offered correct answers to both of the two claims about this visualisation. 60% offered correct answer to one of the two claims. The claims with the correct answers are presented in Table 4 below. 73% felt that this visualisation would need text to support understanding. Nevertheless, 60% of the respondents (62.6 of female and 57.14 of male) considered these kinds of visualisations suitable for the reports generated to their company.

Table 4 summarizes the responses for questions 1 and 2 regarding the Matter 2 in both surveys.

Matter 2: Development levels of Market Intelligence function							
Conceptual diagrams				Visual metaphors			
1. I understand the message that has been signalled through this visualisation.				1. I understand the message that has been signalled through this visualisation.			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	10	83,33 %	1	Yes	11	73,33 %
2	No	2	16,67 %	2	No	4	26,67 %
	Total	12	100 %		Total	15	100 %
2. This visualisation signals that a. one can move from fire-fighter to futurist through different steps				2. This visualisation signals that a. one can move from fire-fighter to futurist through different steps			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	9	75,00 %	1	Yes	8	53,33 %
2	No	3	25,00 %	2	No	7	46,67 %
	Total	12	100 %		Total	15	100 %
b. MI-program is brought into use at the beginners' level				b. MI-program is brought into use at the beginners' level			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	5	41,67 %	1	Yes	5	33,33 %
2	No	7	58,33 %	2	No	10	66,67 %
	Total	12	100 %		Total	15	100 %

Table 4. Answers for questions 1 and 2 in Matter 2. The correct answers for question 2 are bolded.

4.3. Matter 3: Value chain analysis

The third Matter presented with visualisations in the surveys described a value chain analysis. In the conceptual diagram survey Figure 14 and related questions were presented. (Note the Finnish version used in the survey can be found in Appendix 1.)

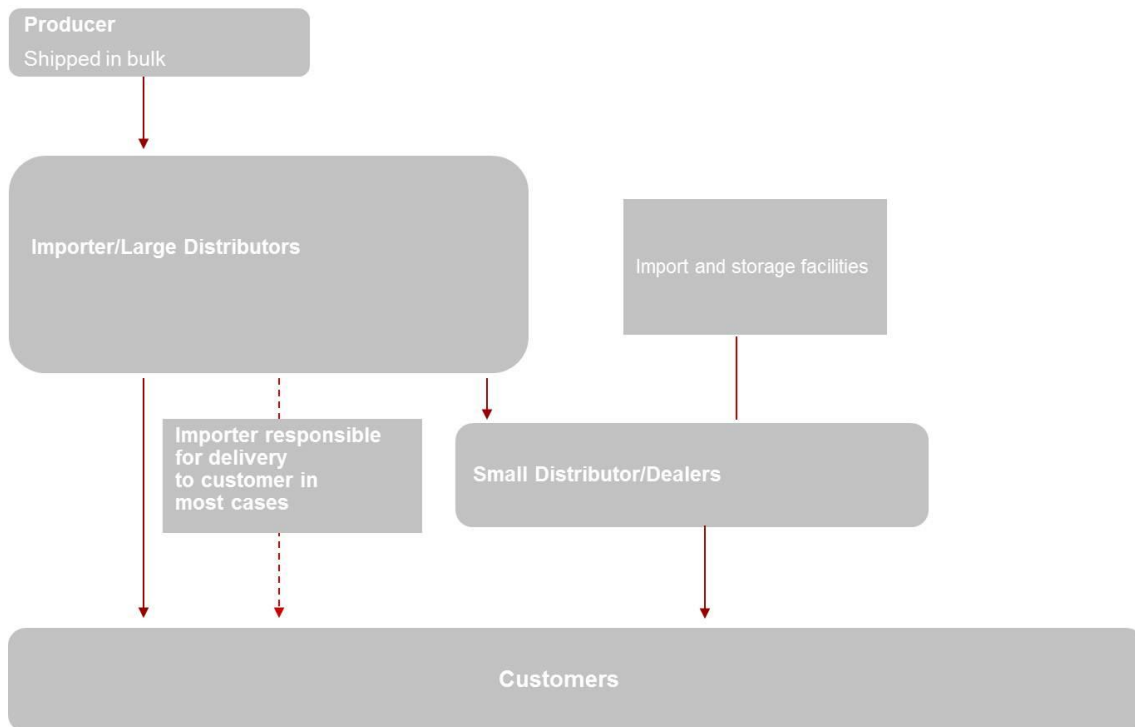


Figure 14. Conceptual diagram 3. Value chain analysis.

58% (7 respondents out of 12) of all respondents indicated that they understand the message signalled through the conceptual diagram in question while only 17% (total of two respondents) offered correct answers to both two claims about the visualisation. 42% of the respondents offered correct answer to one of the two claims. Table 5 below presents the claims with the correct answers. Half of the respondents (50%) thought that the visualisation needed text to support understanding. A total of 75% of the respondents were willing to accept these kinds of visualisations for the reports generated to their company. 71% of men supported these kinds of visualisation for company reports, which is considerably more than the 20% share of female respondents.

In the visual metaphors survey Figure 15 and related questions were presented. (Note the Finnish version used in the survey can be found in Appendix 2.)



Figure 15. Visual metaphor 3. Value chain analysis.

Only 33% (5 respondents out of 15) thought that they understand the message that has been signalled through this visual metaphor. Still 40% of the respondents offered correct answers to both of the two claims about this visualisation and 53% offered correct answer to one claim. The claims with the correct answers are presented in Table 5. All respondents (100%) said that the visualisation in question would need text to support understanding and only 33% of the respondents thought that these kinds of visualisations would be suitable for the reports generated to their company. Female

respondents were more supportive to the visualisation with 38% versus 29% of male respondents.

Table 5 summarizes the responses for questions 1 and 2 regarding Matter 3 in both surveys.

Matter 3: Value chain analysis							
Conceptual diagrams				Visual metaphors			
1. I understand the message that has been signalled through this visualisation.				1. I understand the message that has been signalled through this visualisation.			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	7	58,33 %	1	Yes	5	33,33 %
2	No	5	41,67 %	2	No	10	66,67 %
	Total	12	100 %		Total	15	100 %
2. This visualisation signals that a. the value is formed as a combined effort of the players				2. This visualisation signals that a. the value is formed as a combined effort of the players			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	5	41,67 %	1	Yes	8	53,33 %
2	No	7	58,33 %	2	No	7	46,67 %
	Total	12	100 %		Total	15	100 %
b. the value is realized at the customer level				b. the value is realized at the customer level			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	5	41,67 %	1	Yes	8	53,33 %
2	No	7	58,33 %	2	No	7	46,67 %
	Total	12	100 %		Total	15	100 %

Table 5. Answers for questions 1 and 2 in Matter 3. The correct answers for question 2 are bolded.

4.4. Matter 4: Forces of competition

The fourth Matter presented with visualisation in the surveys described the forces of competition. In the conceptual diagram survey Figure 16 and related questions were presented. (Note the Finnish version used in the survey can be found in Appendix 1.)

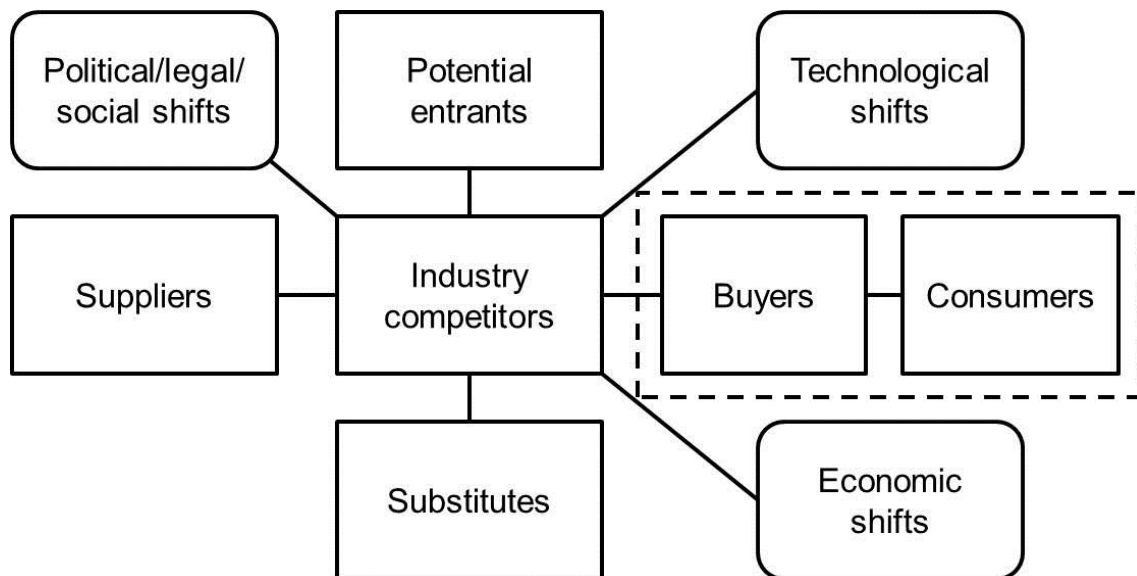


Figure 16. Conceptual diagram 4. Forces of competition.

Altogether 75% (9 respondents out of 12) indicated that they understand the message that has been signalled through this conceptual diagram. Yet, none of the respondents offered correct answers to both claims about the visualisation. This visualisation was the only one where none of the respondents were able to offer correct answers to both claims. And only 38% offered correct answer to one of the claims. The claims with the correct answers are presented in Table 6 below. The majority of the respondents (92%) thought that the visualisation in question would need text to support understanding and 50% agreed that these kinds of visualisations would be suitable for the reports generated to their company. 60% of female versus 43% of male respondents considered this kind of visualisation suitable.

In the visual metaphors survey Figure 17 and related questions were presented. (Note the Finnish version used in the survey can be found in Appendix 2.)

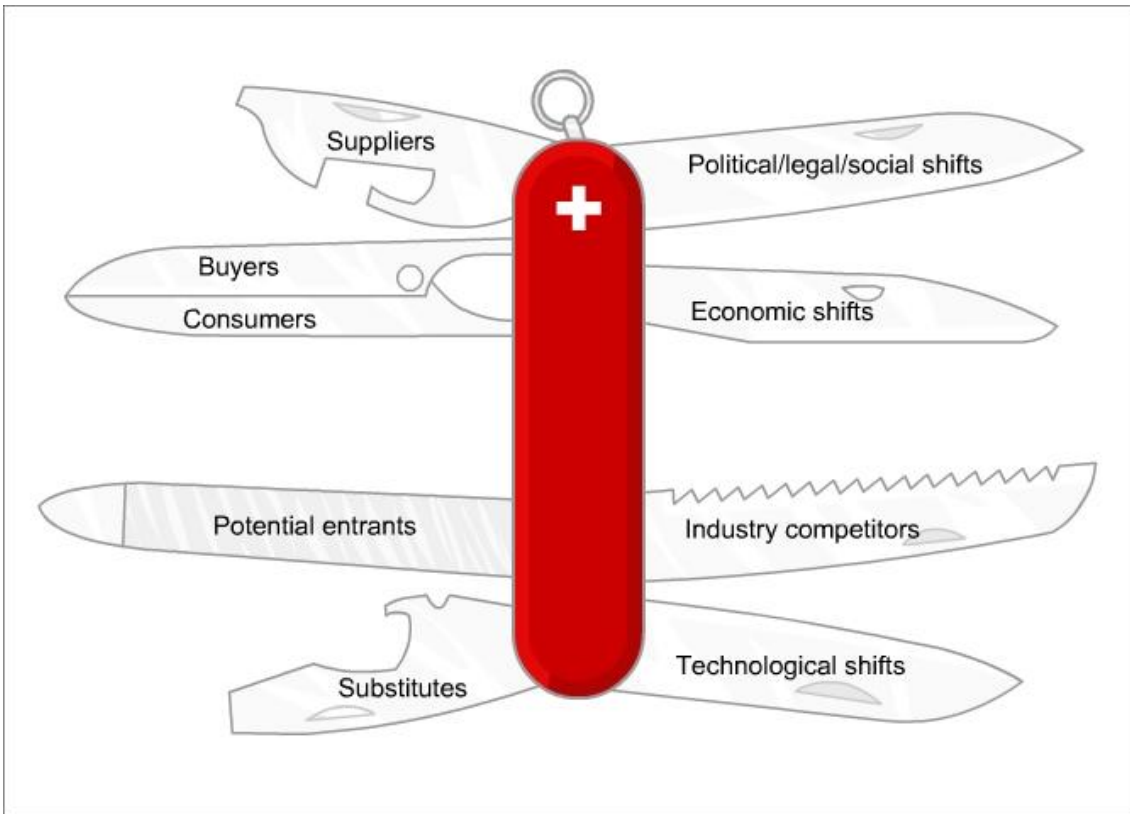


Figure 17. Visual metaphor 4. Forces of competition.

Only 20% (3 respondents out of 15) of the respondents said they understand the message signalled through this visual metaphor. Still, 33% did offer correct answers to both of the two claims about the visualisation and a total of 60% of the respondents offered correct answer to one of the claims. Table 6 presents the claims with the correct answers. 87% indicated that the visualisation would need text to support understanding. Merely 27% (25% of female and 29% of male respondents) considered these kinds of visualisations suitable for the reports generated to their company.

Table 6 summarizes the responses for questions 1 and 2 regarding Matter 4 in both surveys.

Matter 4: Forces of competition							
Conceptual diagrams				Visual metaphors			
1. I understand the message that has been signalled through this visualisation.				1. I understand the message that has been signalled through this visualisation.			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	9	75,00 %	1	Yes	3	20,00 %
2	No	3	25,00 %	2	No	12	80,00 %
	Total	12	100 %		Total	15	100 %
2. This visualisation signals that				2. This visualisation signals that			
a. all the components presented in the picture are equal				a. all the components presented in the picture are equal			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	2	16,67 %	1	Yes	7	46,67 %
2	No	10	83,33 %	2	No	8	53,33 %
	Total	12	100 %		Total	15	100 %
b. the parts presented in the picture are independent components				b. the parts presented in the picture are independent components			
	Answer	Count	Percent		Answer	Count	Percent
1	Yes	7	58,33 %	1	Yes	11	73,33 %
2	No	5	41,67 %	2	No	4	26,67 %
	Total	12	100 %		Total	15	100 %

Table 6. Answers for questions 1 and 2 in Matter 4. The correct answers for question 2 are bolded.

4.5. Comparison of the results

In this subsection the visual metaphor survey results are compared with the conceptual diagram ones. Table 7 offers an overview of all the visualisations used in the surveys.

	Conceptual diagram	Visual metaphors
Matter 1: Market Intelligence functions supporting the decision making		
Matter 2: Development levels of Market Intelligence function		
Matter 3: Value chain analysis		
Matter 4: Forces of competition		

Table 7. Overview of all the visualisations used in surveys.

In the context of all four matters investigated more conceptual diagram survey respondents than visual metaphor survey respondents indicated that they understand the message signalled. On average 77% of the respondents indicated that they understand the message that the conceptual diagram was trying to convey. The corresponding figure for the visual metaphors survey was 47%. Thus, the difference between indicated understanding of conceptual diagrams and visual metaphors is 30 percentage units. Table 8 presents the percentages of the respondents who indicated understanding for all four matters for both surveys.

However, on average 30% of the respondents of the visual metaphor survey offered correct answers to both of the presented claims, while only on average 17% of the respondents in the conceptual diagram survey offered correct answers to both claims. (See Table 9.) This difference means that visual metaphor claims were answered correctly more often than conceptual diagram ones and the difference is 13 percentage units. The results indicate that in Matters 1 and 2 the message was transferred slightly (~1,7 percentage units) better through conceptual diagrams. In Matters 3 and 4 the message was transferred considerably (~23 & 33 percentage units) better through visual metaphors.

	I understand the message that has been signalled through this visualisation.			
	Conceptual diagrams		Visual metaphors	
Matter 1	11	91,67 %	9	60,00 %
Matter 2	10	83,33 %	11	73,33 %
Matter 3	7	58,33 %	5	33,33 %
Matter 4	9	75,00 %	3	20,00 %
Average	9,25	77,08	7	46,67

Table 8. Number and percentage of respondents who indicated that they understand the message of visualisation.

	Correct answers to both of the claims.	
	Conceptual diagrams	Visual metaphors
Matter 1	8,33 %	6,67 %
Matter 2	41,67 %	40,00 %
Matter 3	16,67 %	40,00 %
Matter 4	0,00 %	33,33 %
Average	16,67 %	30,00 %

Table 9. Percentage of the respondents who offered correct answers to both claims.

In the conceptual diagram survey on average 80% of female respondents and 75% of male respondents said that they understand the message signalled through the

conceptual diagrams. Thus, 5 percentage units more females than males indicated understanding. In the visual metaphors survey 41% of female respondents versus 54% male respondents indicated that they understood the message, i.e. 13 percentage units more males than females indicated understanding.

In the visual metaphors survey the confidence of understanding rises from 33% in the age group of 31–40 to 42% in the age group of 41–50 and again to 60% in the age group of over 51, while in the conceptual diagrams survey 94% of the respondents belonging to the age group of 31–40 versus 75% of those in the age group of 41–50 thought that they understood the message. The age group 25–30 is not considered here as in both surveys this particular age group consisted of only one respondent.

In the conceptual diagram survey all the respondents who had answered correctly had also indicated that they understand the message. No such strong correlation was found in the visual metaphors survey. Only in Matter 2 all the respondents who had answered correctly had also thought that they understand the message. In Matter 1 the only person with correct answers to both claims had not indicated that she had understood the message signalled through the visual metaphor, although nine other respondents had thought that they understand the message. In Matter 3 four out of six who had delivered the correct answers had thought that they understand the message. In Matter 4, even though five respondents had answered correctly to both claims, only one of them had thought that she understood the message.

On average 71% of the respondents thought that the kind of conceptual diagrams used in the survey would be suitable visualisations for the reports that are generated for their company. The corresponding figure for visual metaphors is 40%. Thus, on average a lot more respondents considered conceptual diagrams suitable for their company reports. On average 70% of female respondents and 71% of male respondents thought that conceptual diagrams were suitable. In the visual metaphors survey 38% of women and 43% of men considered the visualisations suitable for their company reports. In both surveys on average more male than female respondents considered the visualisations

suitable, although, the difference between male and female respondents was higher in the visual metaphor survey. Among female respondents the only metaphor that gained an over 50% support was the ladder metaphor visualising Matter 2. In addition to Matter 2, Matter 1 got over 50% support among male respondents. But as a result of low support from female respondents for Matter 1 metaphor, only the metaphor of Matter 2 gained over 50% total support. On the contrary, all conceptual diagrams got over 50% total support. The lowest support rate was 20% of the females who thought that the conceptual diagram of Matter 3 would be suitable for their company reports. Conceptual diagram of Matter 3 was, in fact, the only diagram that got under 50% support from female respondents. Meanwhile, the conceptual diagram visualising Matter 4 was the only diagram receiving under 50% support from the male respondents. Table 10 presents how many respondents considered each visualisation suitable for their company reports.

	This kind of visualisations would be appropriate in reports generated for our company.					
	Conceptual diagrams			Visual metaphors		
	Male	Female	All	Male	Female	All
Matter 1	100,00 %	100,00 %	100,00 %	57,14 %	25,00 %	40,00 %
Matter 2	71,43 %	100,00 %	83,33 %	57,14 %	62,50 %	60,00 %
Matter 3	71,43 %	20,00 %	50,00 %	28,57 %	37,50 %	33,33 %
Matter 4	42,86 %	60,00 %	50,00 %	28,57 %	25,00 %	26,67 %
Average	71,43	70,00	70,83	42,86	37,50	40,00

Table 10. Percentages of respondents considering visualisation suitable for their company reports.

On average 75% of the respondents in the age group of 31–40 thought that conceptual diagrams would be suitable for the company reports. In the age group of 41–50 the corresponding result was 68%. The use of visual metaphors in company reports got most support from the oldest age group (over 51). On average 65% of them said that visual metaphors would be suitable for the company reports. Considerable fewer (33) in the younger age group of 41–50 were willing to accept visual metaphors as part of their

reports. Again only (16,67) of the younger age group of 31–40 supported, on average, visual metaphors for reports. Hence, in the visual metaphor survey the older the age group was the more it supported visual metaphors. The age group of 25–30 was not analysed here as it contained only one member.

An average of 73% of respondents reported that the conceptual diagrams presented in the survey would need text to support understanding. The corresponding figure for visual metaphors is 82 %. In the conceptual diagram survey more male (79%) than female (65%) respondents indicated the need of text. In the visual metaphor survey the difference between male respondents (82%) and female respondents (81%) was minimal.

5 DISCUSSION AND CONCLUSIONS

This final chapter first discusses the findings of the present study and seeks to link them to previous research presented in the literature review. Because the present study was conducted in an emerging field the linking cannot be done in depth. In this chapter the summary of the study is given and the main findings are highlighted. Implications and practical recommendations are also identified. Finally, the limitations and suggestions for further research are discussed.

5.1. Discussion of findings

This section first presents the main findings of the present thesis and then discusses the results in more detail. As a result of two separate online surveys, one conducted on conceptual diagrams and the other on visual metaphors, the following main findings were discovered.

Firstly, the findings presented in Chapter 4 suggest that both conceptual diagrams and visual metaphors may lead to an illusion of understanding. Secondly, they indicate that both visualisation methods examined in the study would need text to support understanding. Thirdly, it was shown that insights cannot be reliably transferred with either conceptual diagrams or visual metaphors when no supporting text is provided. However, it is good to acknowledge that since knowledge is always personalised, no two persons can ever have exactly the same knowledge. The findings also suggest that conceptual diagrams are regarded more suitable visualisation method than visual metaphors for business reports. The findings of the present thesis are next discussed in more detail.

To enable the reader to understand the findings presented here, first the logic with which the results were interpreted is presented. It is the assumption here that the respondent has understood the message transferred through a visualisation if the

respondent has offered correct answers to both of the two claims presented of the visualisation. Even though the percentages of respondents who have answered correctly to one of the claims presented of each matter have been reported in the findings, no further conclusions are made based on those figures. It is the underlying understanding that as the respondent has a 50 percentage chance to answer correctly to yes/no-type of claims used in the surveys, answering correctly to one of the claims does not yet indicate understanding.

The conceptual diagram respondents were more confident than the visual metaphor respondents that they understand what has been communicated through the visualisation. Perhaps the respondents were more familiar with and thus more confident with conceptual diagrams. While in the conceptual diagram survey all the respondents who had answered correctly had also indicated that they understand the message, with visual metaphors more respondents answered correctly than were certain that they had understood. Thus, respondents were more uncertain of their understanding when efforts were made to transfer knowledge through visual metaphors.

However, it has to be emphasised that the results do not indicate that the correlation between the feeling of understanding and answering correctly would be greater with conceptual diagrams. On the contrary, many respondents who had thought they did understand the message signalled through a conceptual diagram did not offer correct answers to both claims. It seems that with conceptual diagrams the respondents who felt that they did not understand really did not, but also that some respondents, who felt that they did understand the message, actually did not. This is potentially dangerous as an illusion of understanding may lead to wrong decisions, as was discussed earlier in chapter 2.

Actually, in both surveys on average more respondents thought that they had understood the message than had offered correct answers to both claims. The gap was bigger with conceptual diagrams, because they got on average fewer correct answers and also more respondents thought they understood the message. Hence, the findings of the present

study seem to be in conformity with Eppler et al.'s (2006 p.36) argument that the use of visualisations may lead to an illusion of understanding. Thus, the findings would suggest that both visual metaphors and conceptual diagrams can create an illusion of understanding. These findings need to be taken into account when considering the use of conceptual diagrams or visual metaphors in Company A's deliverables. As decisions are made based on reports generated by Company A, it is important to avoid the illusion of understanding. This is one of the practical recommendations of the present thesis.

The findings of the present study also suggest that while the respondents feel that they better understand a message signalled with conceptual diagrams, visual metaphors actually seem to transfer the message better. However, it must be remembered that in the present surveys only four conceptual diagrams and visual metaphors were studied and the results can best be associated with only these specific visualisations. The results are to a large extent dependent on the particular visualisations that were chosen for the visual metaphors and conceptual diagrams survey. This will be further discussed in the limitations section.

None of the visualisations, neither conceptual diagrams nor visual metaphors, examined in the surveys were able to transfer the message so that more than 50% of the respondents would have answered correctly to both of the two claims presented. In fact the best score was 42% of respondents which was achieved in the conceptual diagram survey with conceptual diagram visualising Matter 2. In contrast to Eppler and Burkhart (2006; 2007), these findings would suggest that there might be challenges involved in efforts to transfer knowledge with conceptual diagrams or visual metaphors.

Nonetheless, it must be noted that the present thesis studied the visualisations without supporting text. Previous studies have suggested that visualisations would need explanations, e.g. text, to support understanding (e.g. Eppler et al. 2006; Eppler et al. 2008). Therefore, this study seems to lend support to Eppler et al.'s (2006 p.36) view that if the visualisation is not explained well enough it may cause ambiguity and misunderstanding. In Company A's case, as the reports are sent to the client in an

electronic PowerPoint format, the explanation can only be given with supporting text. The finding is further supported with the results of the present surveys. While on average more respondents indicated that the supporting text would be needed in the context with visual metaphors than in the context with conceptual diagrams, in both surveys the majority of the respondents felt that the visualisation would need text to support understanding. Thus, it could be argued, that both visualisation methods, conceptual diagrams and visual metaphors, need text to support understanding. Because the present thesis studied the transfer of knowledge with visualisations which were not supported by explanations this needs to be considered in the findings. The results may have been completely different if text would have been provided to support understanding. Thus the findings suggest that knowledge cannot be transferred reliably with either conceptual diagrams or visual metaphors when no supporting text is provided. On the other hand, as discussed in the literature review (Chapter 2) knowledge is always personalised and thus, no other person can have exactly the same knowledge as the person communicating it.

On average more female than male respondents considered that they understand the message signalled through conceptual diagrams. Instead, on average more male respondents thought that they understand the message signalled through visual metaphors. This could indicate that women are more comfortable with conceptual diagrams and men, more than women, feel that they understand visual metaphors. On the other hand there are other demographic features that could explain the difference. The female respondents belonged on average to older age groups in the conceptual diagrams survey and the male representatives in the visual metaphors survey belonged to older age groups than female respondents. This could indicate that the feeling of understanding the visualisations is not gender related, but rather age dependent. This view gets support when understanding is studied through age groups in the visual metaphor survey. The higher the age group is the more confident of the understanding the respondents seem to be. On the other hand, in the conceptual diagrams survey more respondents in the age group 31–40 than in the age group of 41–50 thought that they understood the message. Thus, the suggestion of age related confidence of

understanding is not fully supported and the differences in confidence of understanding may be explained with gender difference or other factors.

On average a considerably larger proportion of respondents considered conceptual diagrams than visual metaphors suitable for their company deliverables. Only 40% of the respondents on average in the visual metaphor survey would have seen visual metaphors as suitable. These findings support previous research which has suggested that visual metaphors might not be seen as a suitable visualisation method for the business environment (e.g. Eppler 2006, p.205). In addition one of the client companies had decided not to forward the survey further to decision makers after testing the survey in a team of two. The content of the survey was reported to be the reason for this decision. This seems to indicate that the deciding team did not consider visual metaphors suitable for their business context.

Men were more tolerant towards visual metaphors, but also their average support remained under 50%. Only one visual metaphor received over 50% of support. This further supports the idea, presented in literature, which suggests that visual metaphors may not be seen as a suitable visualisation method in the context of business. Thus, it seems that conceptual diagrams are more easily accepted as a visualisation method for company reports than visual metaphors. The findings also suggest that visual metaphors are mostly not seen as a suitable visualisation method in business reports, and that conceptual diagrams, on the other hand, are mostly seen as a suitable visualisation method. However, it is important to remember that these results can best be associated only with the specific visualisations chosen for the surveys.

Interestingly the oldest age group (over 51) was most tolerant towards visual metaphors with on average 65% of the respondents saying that visual metaphors could be used in their company reports. The younger the age group was the less support it gave to visual metaphors. This would indicate that older decision makers are more open to the use of visual metaphors. The effect of gender cannot, however, be ruled out, since the youngest age group here consisted only of women and both of the older age groups had

more male respondents. And as presented above, male respondents were more tolerant towards visual metaphors. Most of the respondents, 71%, supported on average the use of conceptual diagrams in their company reports. The support was somewhat higher in the younger age group of 31–40 than in the older age group of 41–50.

Consequently, the findings suggest that male respondents accept visual metaphors to their company reports more easily. The findings also suggest that older decision makers are more tolerant towards visual metaphors. In addition, it seems that male respondents are slightly more tolerant towards conceptual diagrams in company reports and that younger decision makers support more the use of conceptual diagrams. However, the correlation between two variables, age and gender, cannot be specified.

Based on the findings presented above the theoretical framework of the present thesis, presented in Chapter 2, has been reformed. The findings suggested that providing a supporting text could help the receiver to understand the message. Figure 18 presents the revised framework.

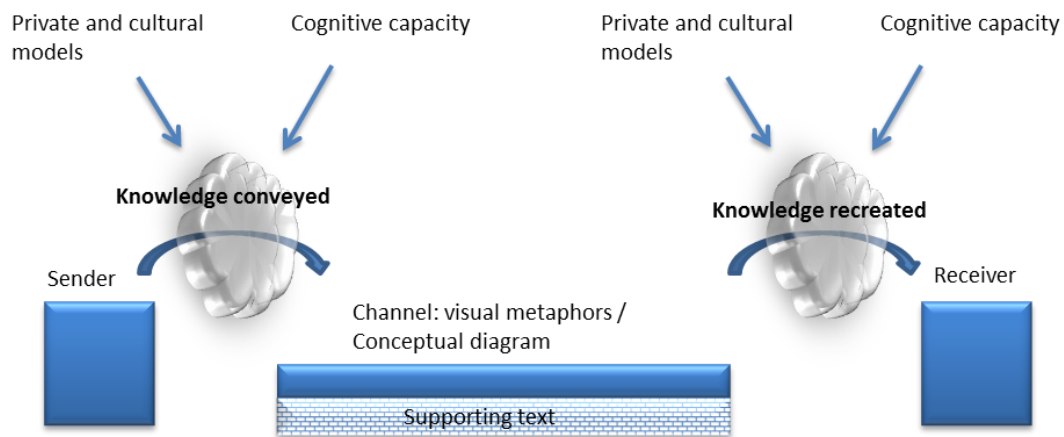


Figure 18. Reformed framework of the present study.

Figure 18 illustrates that the sender conveys the knowledge which is transmitted to the receiver through either a visual metaphor or a conceptual diagram with the help of

supporting text. The cognitive capacity and the private and cultural models of the sender affect his ability to convey the message. The receiver recreates the knowledge in his own mind, while the cognitive capacity as well as the private and cultural models affect the success of the transfer. The knowledge might not reach the receiver or it might reach the receiver only partly. Similarly the knowledge that reaches the receiver might not be the same knowledge the sender intended to communicate.

It must be kept in mind that in the present surveys only four conceptual diagrams and visual metaphors were studied. Thus, the results are to a large extent dependent on the visualisations chosen to surveys and the results can best be associated only with these specific visualisations.

5.2. Research summary

The purpose of the present thesis was to find out about the reactions of Company A's clients to specific knowledge visualisation methods. Knowledge visualisation is a type of knowledge communication. Knowledge visualisation was defined as a way to convey complex insights with visual means so that the receiver can remember them and act according to them.

Knowledge visualisation is an emerging field of study and moreover the use of visualisations in business deliverables is a less examined subject in the field. The present thesis was motivated by a practical need of Company A. Company A has a need to communicate knowledge to support their client's decision making processes and successful knowledge communication through reports is essential for their operations. On this basis it was decided that the present study will concentrate on transferring know-what asynchronously with computer based visualisation methods to Company A's customers.

The present thesis examined the problem of knowledge transfer to Company A's customers' decision makers with specific knowledge visualisation methods. The following research questions were formed.

1 A. Could conceptual diagrams be used for knowledge transfer to Company A's customers' decision makers?

1 B. Could visual metaphors be used for knowledge transfer to Company A's customers' decision makers?

The practical implications of the present study aim at helping Company A's consultants to use knowledge visualisation in future reports and suggest which visualisation means could be used in future deliverables.

The literature review first discussed the difference between data, information and knowledge. It was concluded that in the present thesis data is understood as raw symbols and information as processed data. When information is understood and given a meaning in the mind of an individual it becomes knowledge. Secondly, differences between information and knowledge visualisation were deliberated. While computer based information visualisation focuses on presenting large amounts of data, knowledge visualisation helps to transfer knowledge with both computer based and non-computer based methods (Eppler and Burkhart 2006). Thirdly, the benefits of visualisations were deliberated. Processing images takes less time and effort than processing text as well as helps to overcome the working memory limitations (e.g. Worren et al., 2002). The use of visualisations makes information more accessible and comprehensive (Eppler, 2003). Visualisations also help to compress information (Eppler, 2003). Fourthly, the concept of knowledge transfer was introduced. In the transfer of knowledge the receiver acts as a learner recreating the knowledge in his own mind (e.g. El Sawy et al., 1997). Private and cultural models (Ringberg & Reihlen) as well as the cognitive capacity of the receiver (e.g. Eppler and Burkhart 2006) affect this reconstruction of knowledge. Fifthly, the use of conceptual diagrams and visual metaphors as knowledge visualisation methods in the present thesis was motivated as follows. Conceptual diagrams and visual

metaphors are suitable for asynchronous electronic use in the PowerPoint format and they can be used in individual-to-individual communication. Moreover, the chosen visualisation methods can be used in knowledge transfer (Eppler and Burkhart, 2006). They can also have high perceived finishedness, which indicates to the receiver that the visualisation is not open to modifications. Despite the arguments in literature which claimed that visual metaphors may be seen unsuitable in the business context (e.g. Eppler 2006, p.205), visual metaphors were chosen as one of the visualisation methods of the present study, because some researchers (e.g. Kernbach and Eppler 2010, p.349) have gained positive results of using them in the business environment. Finally, the limitations of visualisations were discussed and it was concluded that visualisations depend on interpretation and can thus be misunderstood, especially when the visualisation is not explained well enough (Eppler and Burkhart, 2006). Also ineffective use of visualisations may lead to an illusion of understanding (Eppler et al. 2006).

The theoretical framework of the present study combined the literature review and Shannon's (1948) traditional communication theory. The framework presented that the sender conveys the message which is communicated through a conceptual diagram or a visual metaphor. The receiver needs to recreate the knowledge in his own mind while his cognitive capacity (e.g. Eppler and Burkhart 2006) and the private and cultural models (Ringberg & Reihlen 2008) affect the success of the transfer. It was reasoned that these factors also affect to the sender's ability to convey the message.

Answers to the research questions were sought with the following methods. A single-case design was selected for the present study. Two separate online surveys were conducted, one on conceptual diagrams, another on visual metaphors. The questions were simple yes-or-no questions. The links to the online surveys were distributed to the contact persons of the client companies of Company A that were willing to participate. The contact persons were instructed to distribute the survey to the strategic or operational decision makers of their company. Quantitative data was analysed in an Excel sheet.

The main findings suggested that both visualisation methods examined, conceptual diagrams and visual metaphors, may lead to an illusion of understanding. They also indicated that both visualisation methods would need text to support understanding. The main findings of the study further seemed to indicate that the insights cannot be reliably transferred with either conceptual diagrams or visual metaphors when no supporting text is provided. However, when examining the transfer of knowledge it is always hard to measure the success of communication as no person can have exactly same knowledge. Knowledge is personalised and recreated in the mind of the receiver and thus, no receiver can have the same knowledge as the person communicating it.

The findings also suggest that conceptual diagrams are seen more suitable visualisation method than visual metaphors for business reports. The results of the present study indicate that the respondents were more confident that they understood the message signalled through conceptual diagrams while more respondents offered correct answers to both claims when the matter was visualised with a visual metaphor. In the light of the results it seems that female respondents were more confident than male respondents that they understood messages signalled through conceptual diagrams and that male respondents were more confident that they understood the message of visual metaphors. However, these results can be considered controversial because the affecting factor could not be clearly identified.

5.2. Practical implications

This section presents the practical implications for Company A generated from the study results.

The results seem to indicate that use of either visual metaphors or conceptual diagrams may lead to an illusion of understanding. As decisions are made based on reports generated by Company A, it is important to avoid the illusion of understanding. Hence,

it is recommended to use text in Company A's deliverables to explain the used visualisations and this way to support understanding.

As mentioned before conceptual diagrams have certain disadvantages. They might be difficult to understand or diagrams may not be suitable tools to present the topic (Eppler 2006). In the present study it is considered important that these shortcomings of conceptual diagrams need to be taken into account when choosing diagrams to Company A's deliverables.

The present thesis recommends careful consideration with the use of visual metaphors in Company A's deliverables since the findings suggest that they may not be seen as a suitable visualisation method for a business context. In addition, as mentioned before visual metaphors can be manipulative, be misunderstood or they can make things that are fundamentally different seem common (Eppler 2006). These points should be kept in mind if visual metaphors are included in Company A's deliverables.

It was an assumption in the present study that if 50% or more of the respondents considered that a certain kind of visualisation could be used in reports generated to their company, the visualisation type can be regarded as suitable for Company A's deliverables. Based on this criterion, all visualisations used in the study, those that were regarded as suitable visualisations to Company A's deliverables are listed in Table 11.


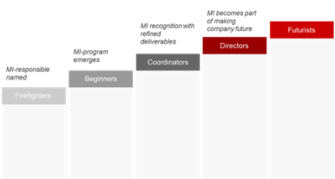
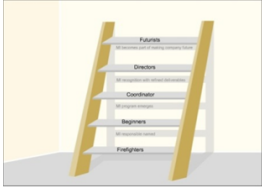
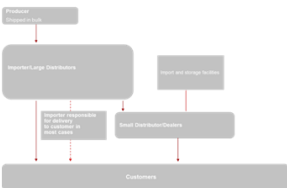
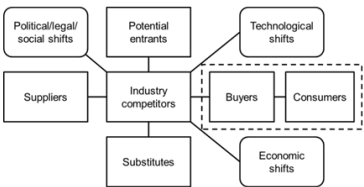
	Conceptual diagram	Visual metaphors
<p>Matter 1: Market Intelligence functions supporting the decision making</p>		
<p>Matter 2: Development levels of Market Intelligence function</p>		
<p>Matter 3: Value chain analysis</p>		
<p>Matter 4: Forces of competition</p>		

Table 11. Visualisations regarded as suitable for Company A’s deliverables.

5.3. Limitations of the present study

This section discusses the limitations of the present study. Most of the weaknesses are related to the question design in the surveys used to examine the topic of the thesis. Other limitations are connected to the field of the study and the research design.

The lack of previous research in the emerging field of knowledge visualisation presented its own challenges for the present thesis. This is why the connection between the results of the study and previous results is only considered to some extent in the discussion section.

The sample of the present study was not large. The conceptual diagram survey received 12 completed answers and the visual metaphors one received 15. Thus the results must be treated with certain reservations. Nonetheless the sample group can be seen as a representation of Company A's Finnish clients' decision makers. And hence, suggestions can be made to Company A. However, the findings can be seen only as suggestive. It is acknowledged that the present study is a single-case study and thus no major generalisation of the results is suggested. Also, literature has argued that single case studies rarely offer basis for generalisations (e.g. Kazdin 1982; Yin 2003).

It also needs to be taken into account that the present thesis studied only four conceptual diagrams and visual metaphors and thus the results can best be associated with only these specific visualisations. The results are to a large extent dependent of the chosen visualisations. If other matters or other visual metaphors or conceptual diagrams were chosen to the survey, the results might be different. However, it is the understanding of the present thesis that the same problem applies in most of the studies conducted on visualisations. Results may be seen as trustworthy as long as all possible weaknesses are acknowledged.

Because only two claims were presented of each visualisation, the likelihood to answer correctly to both claims by accident is the same as throwing heads with a coin two times in a row. This feature can be seen to question the survey method of the study. It might be that the respondent has not understood the message but rather got lucky. But as each survey contained four visualisations, to answer correctly to all questions with mere luck would be the same as throwing heads eight times in a row. This is already more unlikely, but possible of course. When it is considered that the surveys got 12 to 15 responses, the effect of pure luck in the results of the surveys is reduced. It is the understanding of the present author that claims with yes-no-answers are a common way to test knowledge for example in exams. Thus it may be seen as an appropriate tool to test the transfer of knowledge.

It is acknowledged that different details in the survey structure may have influenced the results. As mentioned before the choice of matters and visualisations can have an effect on the results to a larger extent. In addition, the formulation of questions and of course the formulation of claims may have affected the results in this, like in any other, survey. The claims were, however, carefully considered with the Product Management Director of Company A. Efforts were made to ensure that each claim could only have one possible correct answer.

An example of a situation where poor question design might have affected the result is the claims generated for Matter 1. Only one respondent answered the two claims correctly, both in the conceptual diagram and visual metaphor survey. This could either indicate that the visualisations of Matter 1 were not transferring the knowledge well enough, that the visualisations were misleading or that the question design was not successful. However, responses were scattered. In the visual metaphors survey 5/15 answered correctly to claim a. and 4/15 answered correctly to claim b. In the conceptual diagrams survey correctly answered 6/15 and 2/15. This shows that neither of the two claims alone could have been the reason for poor success. Because the responses were scattered, it cannot be clearly shown that either of the claims would have been misrepresentative. Nevertheless, both visualisations, conceptual diagram and visual metaphor, of Matter 1 got fewer correct answers than the rest of the visualisations. This might mean that the claims were not well designed. On the other hand, both visualisation methods used the same logic and thus the reason for the poor success might also lie in the logic of the visualisations.

Another aspect affecting the results is the design of the visualisations. Did they reflect what was intended? On the other hand, this is the exact purpose of the study. The visualisation is always made by someone and interpreted by someone else. As Tergan and Keller (2005, p.10) argue, finding a good metaphor for abstract data is challenging. In this study efforts were made to test if knowledge can be transferred through visualisation from the message sender to the receiver. The design of the visualisation is part of this process. The argument of Groves et al. (2009, p.226) should also be

considered; “although it is very difficult to say how often respondents misunderstand survey questions, there are several indications that it happens quite frequently”. In this survey this is especially problematic, particularly as regards the claims; if the respondent understands the claim wrongly he/she cannot be able to answer it correctly, and in this case the claim would not measure if the respondent had understood the message signalled through the visualisation.

Yet, another possible weakness is related especially to the claims. Groves et al. (2009, p.228) argue that because the person preparing the questions is often an expert in his area, he may overestimate the knowledge of the respondents and use terminology that the respondents are not familiar with. It is possible that too complex terminologies were used in the context of the claims. On the other hand, because the matters visualised in the survey should be familiar to most decision makers in business, it is possible that the decision makers answered to the claims based on their previous knowledge, even though they were instructed to answer them based only on the visualisations.

Because of the online survey tool functionalities it was not possible to hide the next questions before the previous ones were presented. Thus the respondents had a possibility to see the claims made of the visualisation while they were answering the “I understand the message that has been signalled through this visualisation” -question. The claims could have effected on the receivers’ feeling of understanding. These claims may have confused the respondents and thus made them more uncertain of the understanding. On the other hand, the test respondents reported that the claims actually gave them hints and they felt that the claims helped them to understand. Without these “hints” the feeling of understanding might have been lower. It is also possible that the claims mislead the respondents to understand the visualisations in a wrong way.

Further, it is necessary to consider here one more issue related to limitations. One of the client contacts refused to forward the visual metaphor survey link outside the test team of two. Their decision might have been based on the attitude towards visual metaphors, because the content of the survey was indicated as a reason for this result. This would

mean that from their company the only survey results given might not have been favourable to visual metaphors, but this may not reflect the feeling of the whole company.

The comparisons of results in the present study were made with the help of percentages. Due to the small sample size one respondent more or fewer considerably affected the total. And because the different demographic groups had different numbers of respondents, the effect of one respondent differed from group to group. Despite these notions the present author decided to use percentages when comparing the result. This decision was made because, as mentioned above, different demographic groups consisted of different numbers of respondents. Thus comparing the mere number of respondents on each question or variable was not possible.

Finally, it is good to acknowledge that it is possible that the respondents who answered the present questionnaire are exceptionally interested in the topic, and as such may be more responsive to visualisations than decision makers on average.

5.4. Suggestions for further research

This section suggests two different topics for further research. As discussed above, the knowledge visualisation field is an emerging one and thus possible research topics are multiple. Hence, only the research suggestions emerging from the present study are discussed here.

First, further research is needed on the topic of success of knowledge transfer through visualisation. This suggestion is twofold. In contrast to Eppler and Burkhart (2006; 2007), the findings of the present thesis seem to show that knowledge cannot be transferred through conceptual diagrams or visual metaphors. However, as the present thesis studied the use of visualisations without explanations, and because Eppler et al. (2006 p.36) argue that without sufficient explanations visualisations can be misleading,

it is here suggested that further research should concentrate on studying visualisations with explanatory texts. It would be further beneficial to compare results of using combination of visuals and supporting text to results of using only visualisations. This could reveal the role of supporting text in understanding the visualisations. In addition, more attention should be given to research comparing the success of knowledge transfer through visualisations with the results of only using text. Secondly, as discussed in the last section, it is difficult to choose research methods that would reveal the success of knowledge transfer. It is the understanding of the present author that the success of knowledge transfer could ultimately be studied through action. Asking the receiver to act upon the message transmitted through the visualisation, could reveal if the receiver understood the message. Hence, in further research on knowledge transfer, action could be used as a measurement of understanding.

Second, the results of the present study indicate that visual metaphors are not seen as a fully suitable visualisation method for business reports. While the present results seemed to lend support to this assumption also presented in previous research, it was not clear why this is so. Is it just the matter of getting used to visual metaphors or are they seen too playful as Eppler (2006, p.205) suggests. Therefore, research on why business people consider visual metaphors unfitting for business context is suggested. Moreover, based on the results it seems that older decision makers support the use of visual metaphors more than their younger colleagues. The reason for this was not studied in the present thesis. Is it for example because they have more experience of different visualisation styles or because they know that reporting styles change over time? Furthermore, the present study results left it unclear which demographic factors were dominant features in this matter. Instead of age related factors this could be a gender issue. Thus, further research is needed on how demographic features may affect the acceptance of the use of visual metaphors.

REFERENCES

Alavi, M. & Leidner, D (2001). *Knowledge management and knowledge management systems: conceptual foundations and research issues*. MIS Quarterly 25 (1), 107–136.

Bellinger, G., Castro, D. & Mills, A. (2004). *Data, Information, Knowledge, and Wisdom*. Retrieved January 12, 2011 from <http://www.systems-thinking.org/dikw/dikw.htm>

Bresciani, S. & Eppler, M. (2010). *Choosing Knowledge Visualizations to Augment Cognition: the Managers' View*. IEEE Proceedings of the 14th International Conference on Information Visualisation. 1550-6037/10

Bresciani, S. & Eppler M. (2009). *Beyond knowledge visualization usability: toward a better understanding of business diagram adoption*. IEEE Proceedings of 13th International Conference on Information Visualisation 978-0-7695-3733-7/09, 474–479.

Bresciani, S., Blackwell, A. & Eppler M. (2008a). *A Collaborative Dimensions Framework: Understanding the Mediating Role of Conceptual Visualizations in Collaborative Knowledge Work*. IEEE Proceedings of the 41st Hawaii International Conference on System Sciences 1530-1605/08.

Bresciani, S., Blackwell, A. & Eppler M. (2008b). *Choosing visualisations for collaborative work and meetings: A guide to usability dimensions*. Darwin College Research Report.

Bowman, J. & Targowski, A. (1987). *Modeling the Communication Process: The Map is Not the Territory*. Journal of business communication 24 (4), p21-34.

Burkhard, R.A. (2005). Towards a framework and model for knowledge visualisation: Synergies between information and knowledge visualization. In S. Tergan & T. Keller (Eds.), *Knowledge and information visualization: searching for synergies* (pp.238–255), Berlin Heidelberg: Springer-Verlag.

Burkhard, R. (2004a). *Learning from Architects: The Difference between Knowledge Visualization and Information Visualization*. University of St. Gallen.

Burkhard, R. (2004b). *Visual Knowledge Transfer between Planners and Business Decision Makers, A Framework for Knowledge Visualization*. Swiss Federal Institute of Technology.

Burkhard, R., Andrienko, G., Andrienko, N., Dykes, J., Koutamanis, A., Kienreich, W., Phaal, R., Blackwell, A., Eppler, M., Huang, J., Meagher, M., Grün, A., Lang, S., Perrin, D., Weber, W., Moere, A.V., Herr, B., Börner, K., Fekete, J-D. & Brodbeck, D. (2007). Visualization Summit 2007: Ten Research Goals for 2010. *Information Visualization* 169 (6), 169–188.

Cañas, A., Carff, R., Hill, G., Carvalho, M., Arguedas, M., Eskridge, T., Lott, J. & Carvajal, R. (2005). *Concept Maps: Integrating Knowledge and Information Visualization*. *Lecture Notes in Computer Science* 3426, 181–184.

Card, S., Mackinlay, J. & Shneiderman, B. (1999). *Readings in Information Visualization: Using Vision to Think*. San Francisco: Morgan Kaufmann.

Card, S. (2007). Information visualization. In A. Sears & J. Jacko (Eds.), *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications* (pp.509–543), New Jersey: Lawrence Erlbaum Associates Inc.

Cerry, C. (1966). *On Human Communication: A Review, a Survey, and a Criticism*. Massachusetts: The Massachusetts Institute of Technology.

El Sawy, O., Eriksson, I., Carlsson, S. & Raven, A. (1997). *Understanding the nature of shared knowledge creation spaces around business processes: an international investigation*. Proceedings of Carnegie Bosch Institute Conference on Knowledge in International Corporations. Rome, Italy.

Eppler, M. (2007). *Knowledge Communication Problems between Experts and Decision Makers: an Overview and Classification*. The Electronic Journal of Knowledge Management, 5 (3), 291–300.

Eppler, M. (2006). *A Comparison between Concept Maps, Mind Maps, Conceptual Diagrams, and Visual Metaphors as Complementary Tools for Knowledge Construction and Sharing*. Information Visualization 5, 202-210.

Eppler, M. (2003). *Managing Information Quality: Increasing the Value of Information in Knowledge-intensive Products and Processes*. Berlin: Springer-Verlag.

Eppler, M. & Burkhard, R. (2007). *Visual representation in knowledge management: framework and cases*. Journal of Knowledge Management 11 (4), 112–122.

Eppler, M. & Burkhard, R. (2006). *Knowledge Visualisation*. Idea Group Inc.

Eppler, M. & Burkhard, R. (2004). *Knowledge Visualisation Towards a New Discipline and its Fields of Application*.

Eppler, M., Mengis, J. & Bresciani, S. (2008). *Seven Types of Visual Ambiguity: On the Merits and Risks of Multiple Interpretations of Collaborative Visualizations*. IEEE Proceedings of 12th International Conference Information Visualisation 1550-6037/08, 391–396.

Eppler, M., Platts, K. & Kazancioglu, E. (2006). *Visual Strategizing –The Systematic Use of Visualization in the Strategy Process*. Università della Svizzera Italiana.

Flyvbjerg, B. (2011). Case Study. In K. Norman, Y. Lincoln (Eds.), *The sage Handbook of qualitative Research* (pp.301-316). CA: Thousand Oaks.

Groves, R. , Fowler, F. Jr, Couper, M., Lepkowski, J., Singer, E. & Tourangeau, R. (2009). *Survey Methodology*. New Jersey: John Wiley & Sons.

Gururajan V. & Gardiner M. (2004). *A case study approach to investigate academic perspective on knowledge and knowledge transfer issues*. University of Southern Queensland.

Hanratty, T., Hammell R., John Y., McNeese M., Oh S., Kim H-W., Minotra D, Strater L., Cuevas H. & Colombo D. (2009). *Knowledge Visualization to Enhance Human-Agent Situation Awareness Within a Computational Recognition-Primed Decision System*. IEEE 978-1-4244-5239-2/09.

Herbert, T., (1977). *Toward an administrative model of the communication process*. The Journal of Business Communication, 14, (4) 25-35.

Keim, D. (2002). *Information Visualization and Visual Data Mining*. IEEE Transactions on Visualization and Computer Graphics 7 (1), 100–107.

Kernbach , S. & Eppler, M. (2010). *The use of visualization in the context of business strategies - An experimental evaluation*. IEEE Proceedings of 14th International Conference Information 1550-6037/10, 349–354.

Laitinen H. (1998). *Tapaustutkimuksen perusteet*. Kuopio: Kuopion yliopiston paino.

Lengler, R. & Eppler, M (2007). *Towards A Periodic Table of Visualization Methods for Management*. Institute of Corporate Communication. University of Lugano, Switzerland.

Novak, J., & Govin D. (1984). *Learning how to learn*. Cambridge: Cambridge University Press.

Pauly, J. (1977). The case for a new model of business communication. *The Journal of Business Communication*, 14 (4), 11-23.

Purchase, H., Andrienko, N., Jankun-Kelly, T., & Ward, M. (2008). Theoretical Foundations of Information Visualization. In A. Kerren, J. Stasko, J. Fekete & C. North, (Eds.), *Information Visualization: Human-Centered Issues and Perspectives* (pp.46–64). Berlin Heidelberg: Springer-Verlag.

Ringberg T. & Reihlen M. (2008). *Towards a Socio-Cognitive Approach to Knowledge Transfer*. *Journal of Management Studies*, 45 (5), 912–935.

Shannon, C. (1948). *A Mathematical Theory of Communication*. *The Bell System Technical Journal*, 27, 379–423.

Tergan, S. & Keller, T. (2005). *Knowledge and information visualization: searching for synergies*. Berlin Heidelberg: Springer-Verlag.

Tergan, S., Keller, T. & Burkhard, R. (2006). *Integrating knowledge and information: digital concept maps as a bridging technology*. *Information Visualization* 5, 167–174.

Ware, C. (2007). Visual Queries: The Foundation of Visual Thinking. In S. Tergan & T. Keller (Eds.), *Knowledge and information visualization: searching for synergies* (pp.27-35). Berlin Heidelberg: Springer-Verlag.

Ware, C. (2004). *Information visualization: Perception for design*. San Francisco: Morgan Kaufmann.

Worren, N., Moore, K. & Elliott, R. (2002). *When theories become tools: toward a framework for pragmatic validity*. *Human Relations*, 55 (10), 1227–1250.

Wrench, J., Thomas-Maddson, C., Richmond, V. & McCroskey (2008). *Quantitative Research Methods for Communication – A Hands-On Approach*. New York: Oxford University Press.

Yin, R. (2009). *Case study research – Design and methods - 4rd edition*. USA: Sage Publications

Yin, R. (2003). *Case study research – Design and methods - 3rd edition*. USA: Sage Publications.

APPENDICES

Appendix 1. Survey of conceptual diagrams

Kysely käsitteellisistä diagrammeista tiedon kommunikoinnissa

Vastaaajan Perustiedot

Ikä

- alle 24
- 25-30
- 31-40
- 41-50
- yli 51

Sukupuoli

- Nainen
- Mies


Asema yrityksessä

- Toimihenkilö
- Asiantuntija
- Esimies
- Johto

Osallistun yrityksen strategiseen ja/tai taktiseen päätöksentekoon

- En koskaan
- Toisinaan
- Usein

Jatka myöhemmin **Jatka >**

 17 %

Kysely käsitteellisistä diagrammeista tiedon kommunikoinnissa

Ohjeet

Seuraavilla kyselysivuilla esitetään ensin visualisointi ja sitten siihen liittyviä kysymyksiä. Visualisointeja on yhteensä 4.

Tutustu ensin visualisointiin ja vastaa tämän jälkeen esitettyihin kysymyksiin. Visualisointi on näkyvässä kysymyksiin vastaamisen aikana.

Kyselyssä emme testaa vastaajan tietoutta, vaan tutkimme sitä, miten viesti välittyy visualisoinnin kautta. Vastaa kysymyksiin oman tulkintasi mukaan.

Vastaathan kaikkiin kysymyksiin, kiitos.

Olen lukenut ohjeet

Kyllä

Jatka myöhemmin

Jatka >

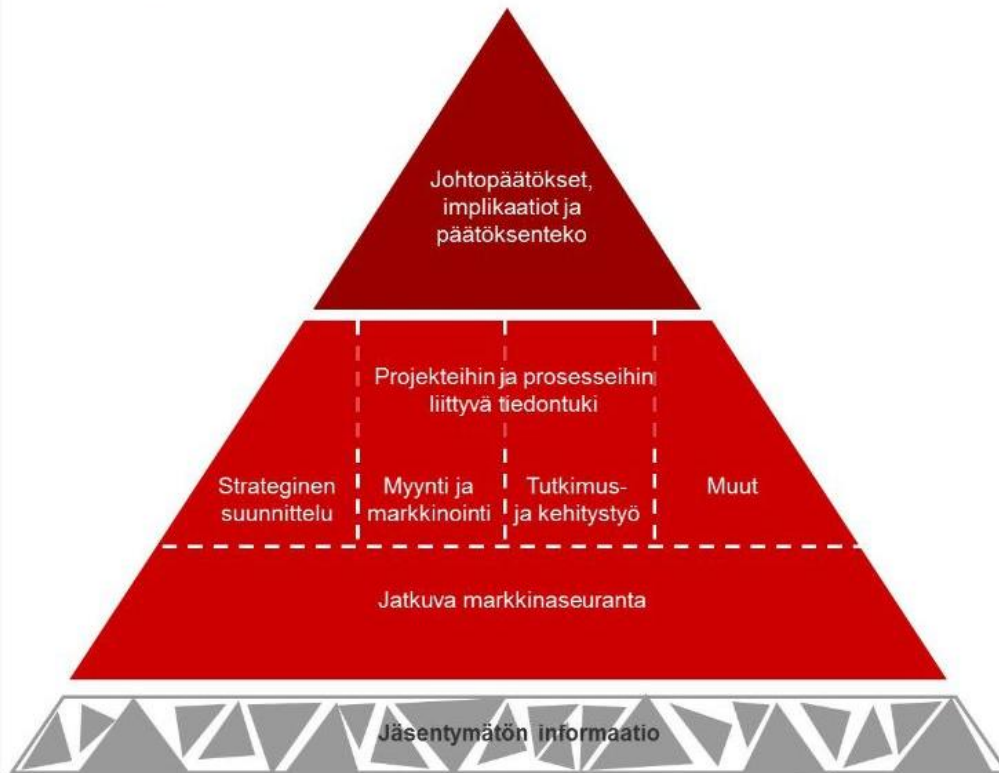


33 %

Kysely käsitteellisistä diagrammeista tiedon kommunikoinnissa

Sivu 3

Vastaa kysymyksiin visualisoinnin perusteella, oman tulkintasi mukaan.



1. Ymmärrän viestin, joka tällä visualisoinnilla halutaan välittää

- Kyllä
 Ei

2. Tämä visualisointi viestittää, että

a. jatkuva markkinaseuranta rakentuu jäsentymättömän tiedon varaan

- Kyllä
 Ei

b. johtopäätökset, implikaatiot ja päätöksenteko koostuvat muista sen alla esitetyistä toiminnoista

- Kyllä
 Ei

3. Sopisivatko tämän tyyliset visualisoinnit yrityksellenne tuottettuihin raportteihin?

- Kyllä
 Ei

4. Visualisointi tarvitsisi tekstiä ymmärtämisen tueksi

- Kyllä
 Ei

Jatka myöhemmin

Jatka >



50 %

Kysely käsitteellisistä diagrammeista tiedon kommunikoinnissa

Sivu 4

Vastaa kysymyksiin visualisoinnin perusteella, oman tulkintasi mukaan.



1. Ymmärrän viestin, joka tällä visualisoinnilla halutaan välittää

- Kyllä
 Ei

2. Tämä visualisointi viestittää, että

a. tulipalojen sammuttajasta voidaan siirtyä futuristiksi eri vaiheiden kautta

- Kyllä
 Ei

b. MI-ohjelma otetaan käyttöön aloittelija-tasolla

- Kyllä
 Ei

3. Sopisivatko tämän tyyliset visualisoinnit yrityksellenne tuottettuihin raportteihin?

- Kyllä
 Ei

4. Visualisointi tarvitsisi tekstiä ymmärtämisen tueksi

- Kyllä
 Ei

Jatka myöhemmin

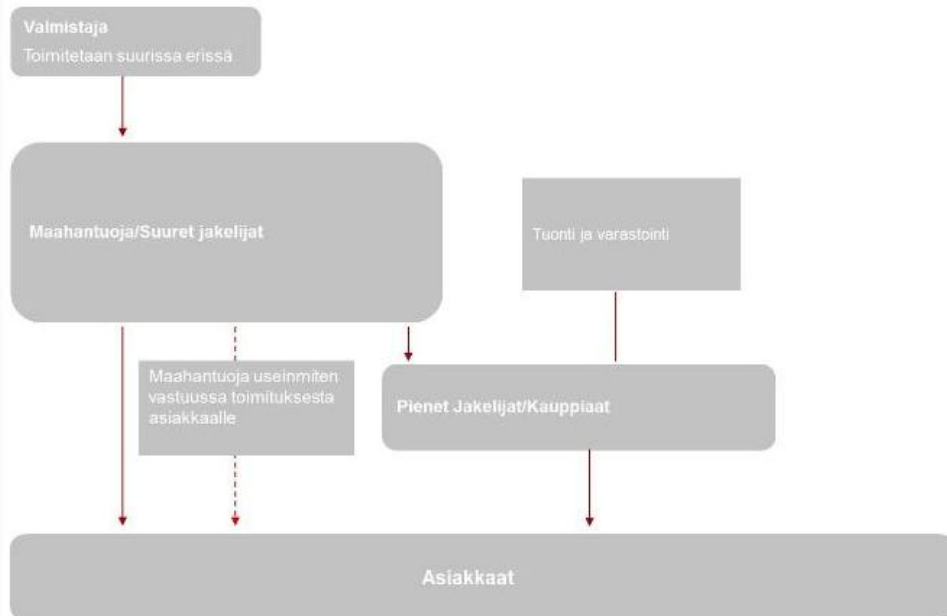
Jatka >

67 %

Kysely käsitteellisistä diagrammeista tiedon kommunikoinnissa

Sivu 5

Vastaa kysymyksiin visualisoinnin perusteella, oman tulkintasi mukaan.



1. Ymmärrän viestin, joka tällä visualisoinnilla halutaan välittää

- Kyllä
 Ei

2. Tämä visualisointi viestittää, että

a. arvo muodostuu toimijoiden yhteisvaikutuksesta

- Kyllä
 Ei

b. arvo muodostuu asiakkaalle

- Kyllä
 Ei

3. Sopisivatko tämän tyyliiset visualisoinnit yrityksellenne tuottettuihin raportteihin?

- Kyllä
 Ei

4. Visualisointi tarvitsisi tekstiä ymmärtämisen tueksi

- Kyllä
 Ei

Jatka myöhemmin

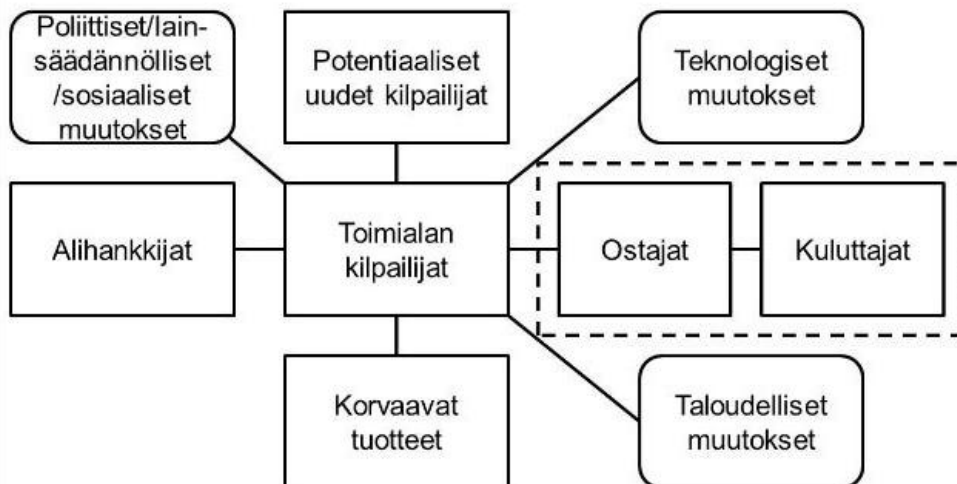
Jatka >

83 %

Kysely käsitteellisistä diagrammeista tiedon kommunikoinnissa

Sivu 6

Vastaa kysymyksiin visualisoinnin perusteella, oman tulkintasi mukaan.



1. Ymmärrän viestin, joka tällä visualisoinnilla halutaan välittää

- Kyllä
 Ei

2. Tämä visualisointi viestittää, että

a. kaikki kuvassa esitetyt osat ovat samanarvoisia

- Kyllä
 Ei

b. kuvassa esitetyt osat ovat itsenäisiä osia

- Kyllä
 Ei

3. Sopisivatko tämän tyyliiset visualisoinnit yrityksellenne tuottettuihin raportteihin?

- Kyllä
 Ei

4. Visualisointi tarvitsisi tekstiä ymmärtämisen tueksi

- Kyllä
 Ei

Jatka myöhemmin

Lähetä

99 %

Kysely käsitteellisistä diagrammeista tiedon kommunikoinnissa

Kiitos vastauksistasi!

Kiitos vastauksistasi!

Powered by  **questback**

100 %

Appendix 2. Survey of visual metaphors

Kysely visuaalisista metaforista tiedon kommunikoinnissa

Vastaajan Perustiedot

Ikä

- alle 24
- 25-30
- 31-40
- 41-50
- yli 51

Sukupuoli

- Nainen
- Mies

Asema yrityksessä

- Toimihenkilö
- Asiantuntija
- Esimies
- Johto

Osallistun yrityksen strategiseen ja/tai taktiseen päätöksentekoon

- En koskaan
- Toisinaan
- Usein

Jatka myöhemmin

Jatka >



17 %

Kysely visuaalisista metaforista tiedon kommunikoinnissa

Ohjeet

Seuraavilla kyselysivuilla esitetään ensin visualisointi ja sitten siihen liittyviä kysymyksiä. Visualisointeja on yhteensä 4.

Tutustu ensin visualisointiin ja vastaa tämän jälkeen esitettyihin kysymyksiin. Visualisointi on näkyvissä kysymyksiin vastaamisen aikana.

Kyselyssä emme testaa vastaajan tietoutta, vaan tutkimme sitä, miten viesti välittyy visualisoinnin kautta. Vastaa kysymyksiin oman tulkintasi mukaan.

Vastaathan kaikkiin kysymyksiin, kiitos.

Olen lukenut ohjeet

Kyllä

Jatka myöhemmin

Jatka >

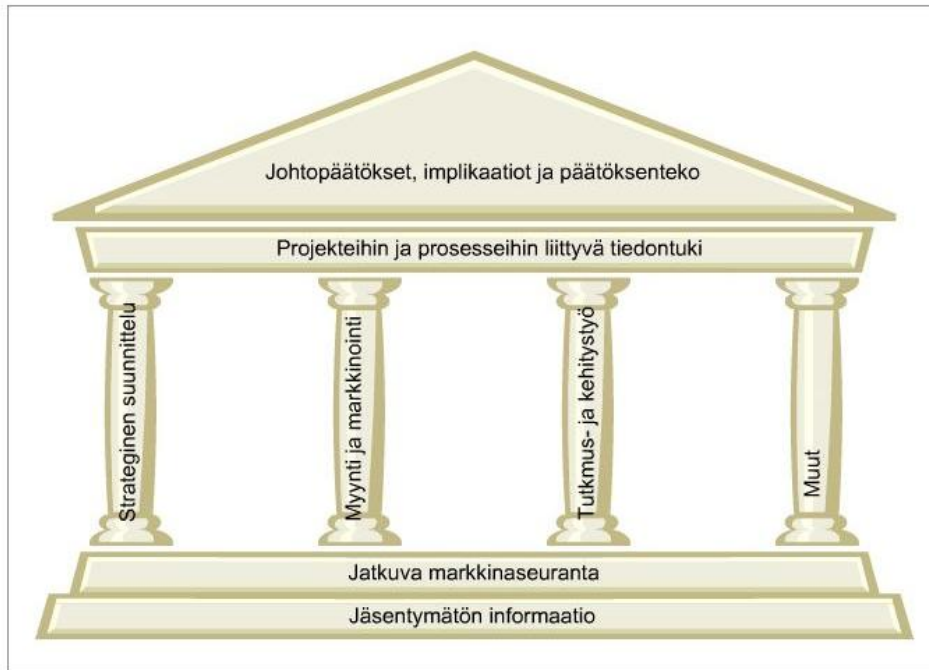


33 %

Kysely visuaalisista metaforista tiedon kommunikoinnissa

Sivu 3

Vastaa kysymyksiin visualisoinnin perusteella, oman tulkintasi mukaan.



1. Ymmärrän viestin, joka tällä visualisoinnilla halutaan välittää

- Kyllä
 Ei

2. Tämä visualisointi viestittää, että

a. jatkuva markkinaseuranta rakentuu jäsentymättömän tiedon varaan

- Kyllä
 Ei

b. johtopäätökset, implikaatit ja päätöksenteko koostuvat muista sen alla esitetyistä toiminnoista

- Kyllä
 Ei

3. Sopisivatko tämän tyylliset visualisoinnit yrityksellenne tuottettuihin raporteihin?

- Kyllä
 Ei

4. Visualisointi tarvitsisi tekstiä ymmärtämisen tueksi

- Kyllä
 Ei

Jatka myöhemmin

Jatka >

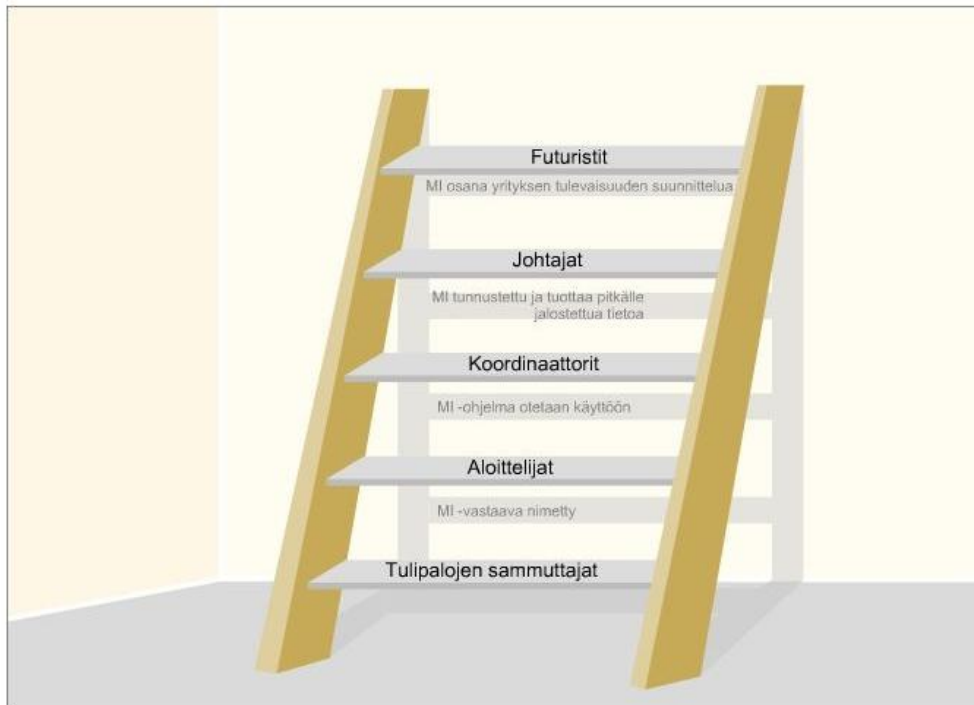


50 %

Kysely visuaalisista metaforista tiedon kommunikoinnissa

Sivu 4

Vastaa kysymyksiin visualisoinnin perusteella, oman tulkintasi mukaan.



1. Ymmärrän viestin, joka tällä visualisoinnilla halutaan välittää

- Kyllä
 Ei

2. Tämä visualisointi viestittää, että

a. tulipalojen sammuttajasta voidaan siirtyä futuristiksi eri vaiheiden kautta

- Kyllä
 Ei

b. MI-ohjelma otetaan käyttöön aloittelija-tasolla

- Kyllä
 Ei

3. Sopisivatko tämän tyyliset visualisoinnit yrityksellenne tuottettuihin raportteihin?

- Kyllä
 Ei

4. Visualisointi tarvitsisi tekstiä ymmärtämisen tueksi

- Kyllä
 Ei

Jatka myöhemmin

Jatka >

67 %

Kysely visuaalisista metaforista tiedon kommunikoinnissa

Sivu 5

Vastaa kysymyksiin visualisoinnin perusteella, oman tulkintasi mukaan.



1. Ymmärrän viestin, joka tällä visualisoinnilla halutaan välittää

- Kyllä
 Ei

2. Tämä visualisointi viestittää, että

a. arvo muodostuu toimijoiden yhteisvaikutuksesta

- Kyllä
 Ei

b. arvo muodostuu asiakkaalle

- Kyllä
 Ei

3. Sopisivatko tämän tyylliset visualisoinnit yrityksellenne tuottettuihin raportteihin?

- Kyllä
 Ei

4. Visualisointi tarvitsisi tekstiä ymmärtämisen tueksi

- Kyllä
 Ei

Jatka myöhemmin

Jatka >

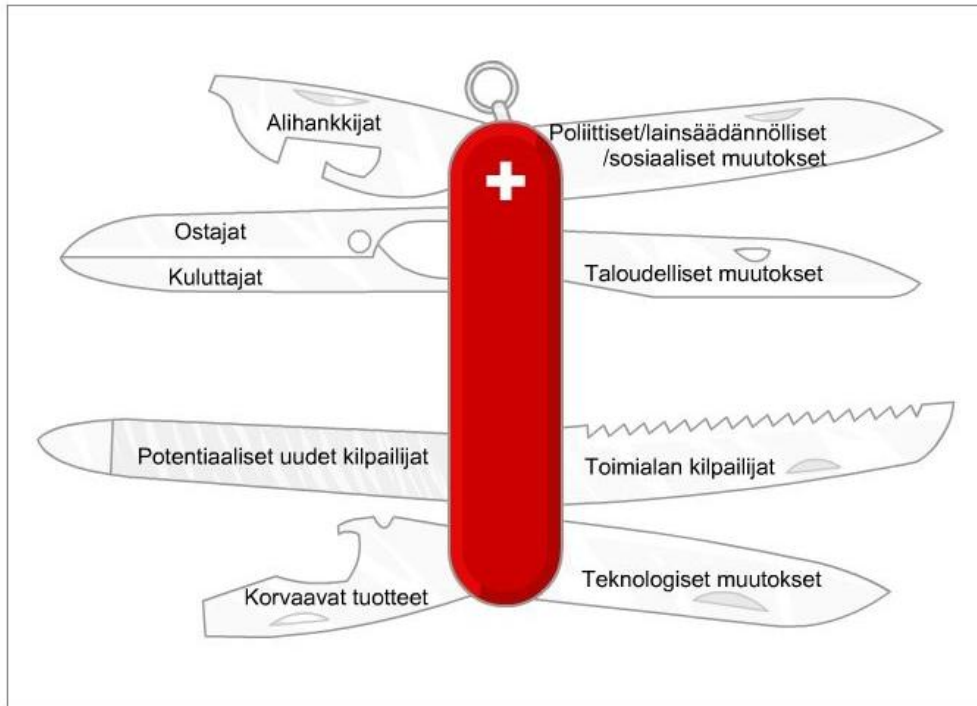


83 %

Kysely visuaalisista metaforista tiedon kommunikoinnissa

Sivu 6

Vastaa kysymyksiin visualisoinnin perusteella, oman tulkintasi mukaan.



1. Ymmärrän viestin, joka tällä visualisoinnilla halutaan välittää

- Kyllä
- Ei

2. Tämä visualisointi viestittää, että

a. kaikki kuvassa esitetyt osat ovat samanarvoisia

- Kyllä
- Ei

b. kuvassa esitetyt osat ovat itsenäisiä osia

- Kyllä
- Ei

3. Sopisivatko tämän tyyliset visualisoinnit yrityksellenne tuottettuihin raportteihin?

- Kyllä
- Ei

4. Visualisointi tarvitsisi tekstiä ymmärtämisen tueksi

- Kyllä
- Ei

Jatka myöhemmin

Lähetä

99 %

Kysely visuaalisista metaforista tiedon kommunikoinnissa

Kiitos vastauksistasi!

Kiitos vastauksistasi!

Powered by  **questback**

100 %

Appendix 3. Translation of conceptual diagrams survey

Demographic data

Age:

24 or under

25-30

31-40

41-50

51 or over

Gender:

Female

Male

Position in the company:

Employee

Expert

Manager

Director

I take part in strategic or operational decision making in my company:

Never

Sometimes

Often

Instructions

In the next pages, first visualisation is presented, and then questions related are asked. The survey includes 4 visualisations altogether.

Study the visualisation first and only then answer the questions presented. The visualisation will be visible during answering.

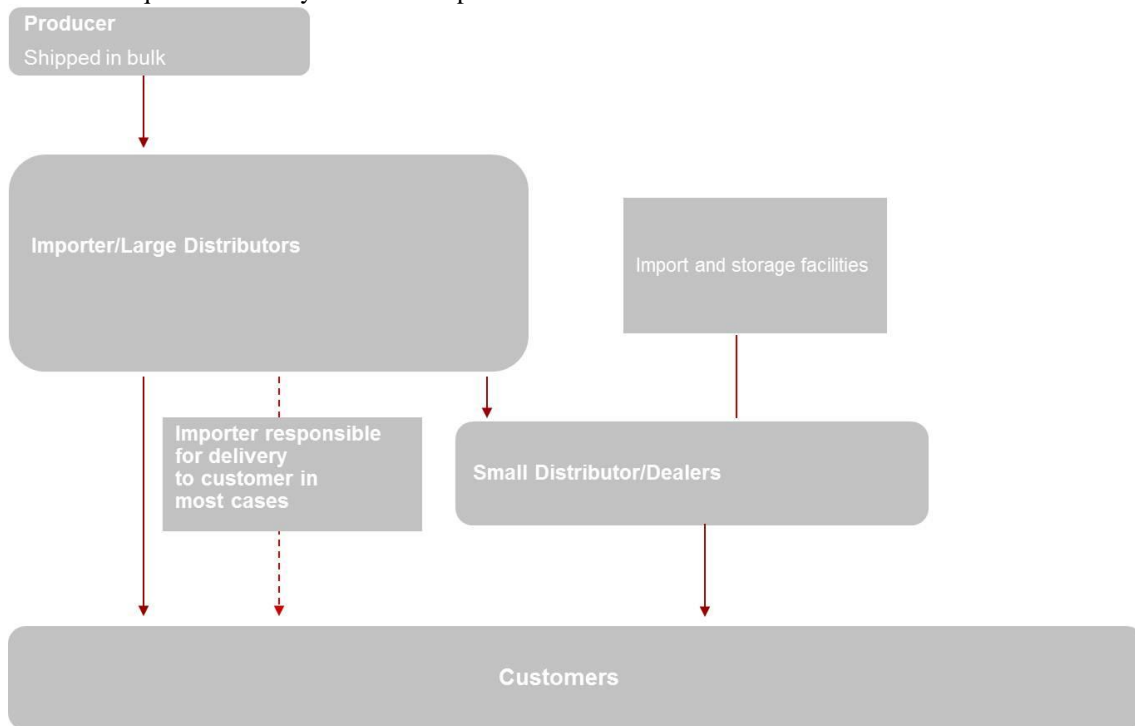
The survey does not test the respondent's knowledge, but examines how the message is transferred through the visualisation.

Answer the questions after your own interpretation of the visualisation.
Please answer all the questions, thank you.

I have read the instructions

Yes

Answer the questions after your own interpretation of the visualisation.



1. I understand the message that has been signalled through this visualisation.

- Yes
- No

2. This visualisation signals that

a. The value is formed as a combined effort of the players

- Yes
- No

b. The value is realized at the customer level

- Yes
- No

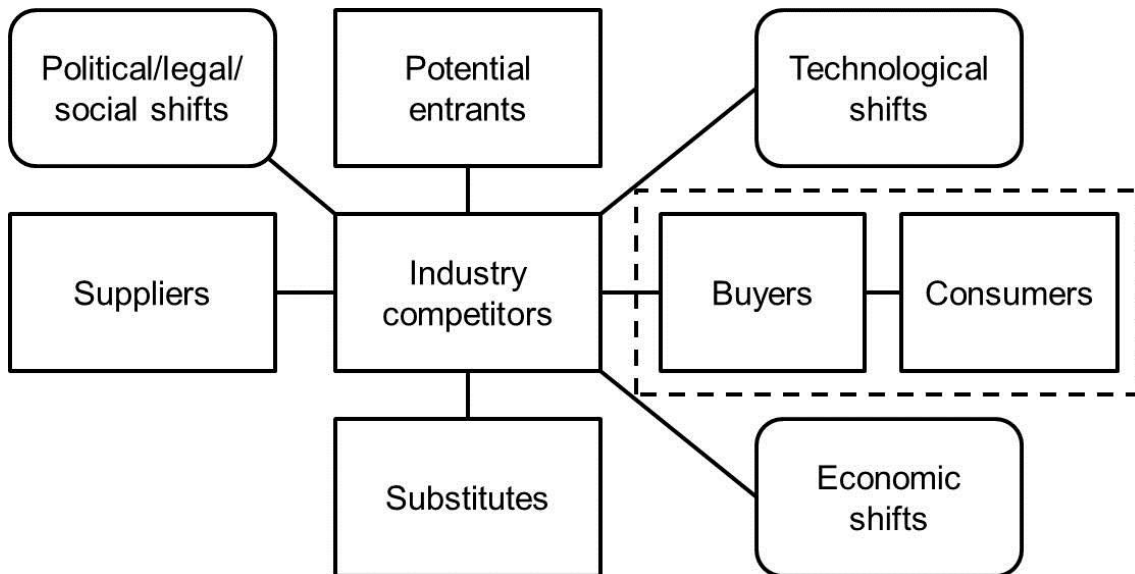
3. Would this kind of visualisations be appropriate in reports generated for your company?

- Yes
- No

4. Visualisation would need text to support understanding.

- Yes
- No

Answer the questions after your own interpretation of the visualisation.



1. I understand the message that has been signalled through this visualisation.

- Yes
- No

2. This visualisation signals that

a. All the components presented in the picture are equal

- Yes
- No

b. The parts presented in the picture are independent components

- Yes
- No

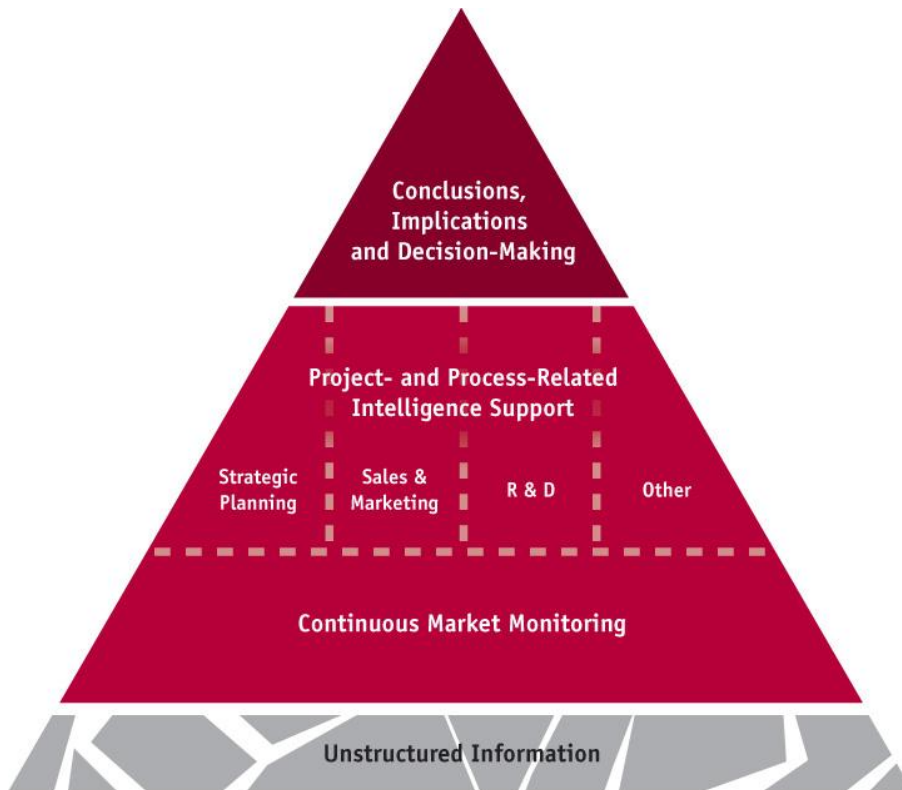
3. Would this kind of visualisations be appropriate in reports generated for your company?

- Yes
- No

4. Visualisation would need text to support understanding.

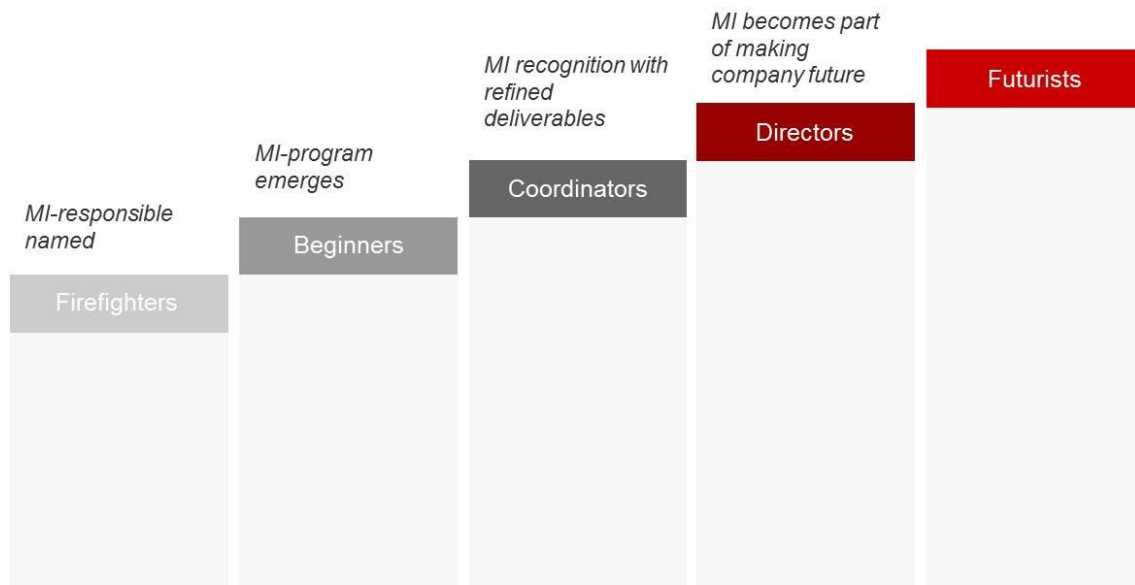
- Yes
- No

Answer the questions after your own interpretation of the visualisation.



1. I understand the message that has been signalled through this visualisation.
Yes
No
2. This visualisation signals that
 - a. Continuous market monitoring is based on unstructured information
Yes
No
 - b. Conclusions, implications and decision-making are composed of the other functions presented under it
Yes
No
3. Would this kind of visualisations be appropriate in reports generated for your company?
Yes
No
4. Visualisation would need text to support understanding.
Yes
No

Answer the questions after your own interpretation of the visualisation.



1. I understand the message that has been signalled through this visualisation.

- Yes
- No

2. This visualisation signals that

a. one can move from fire-fighter to futurist through different steps

- Yes
- No

b. MI-program is brought into use at the beginners' level

- Yes
- No

3. Would this kind of visualisations be appropriate in reports generated for your company?

- Yes
- No

4. Visualisation would need text to support understanding.

- Yes
- No

Appendix 4. Translation of visual metaphors survey

Demographic data

Age:

24 or under

25-30

31-40

41-50

51 or over

Gender:

Female

Male

Position in the company:

Employee

Expert

Manager

Director

I take part in strategic or operational decision making in my company:

Never

Sometimes

Often

Instructions

In the next pages, first visualisation is presented, and then questions related are asked. The survey includes 4 visualisations altogether.

Study the visualisation first and only then answer the questions presented. The visualisation will be visible during answering.

The survey does not test the respondent's knowledge, but examines how the message is transferred through the visualisation.

Answer the questions after your own interpretation of the visualisation.
Please answer all the questions, thank you.

I have read the instructions

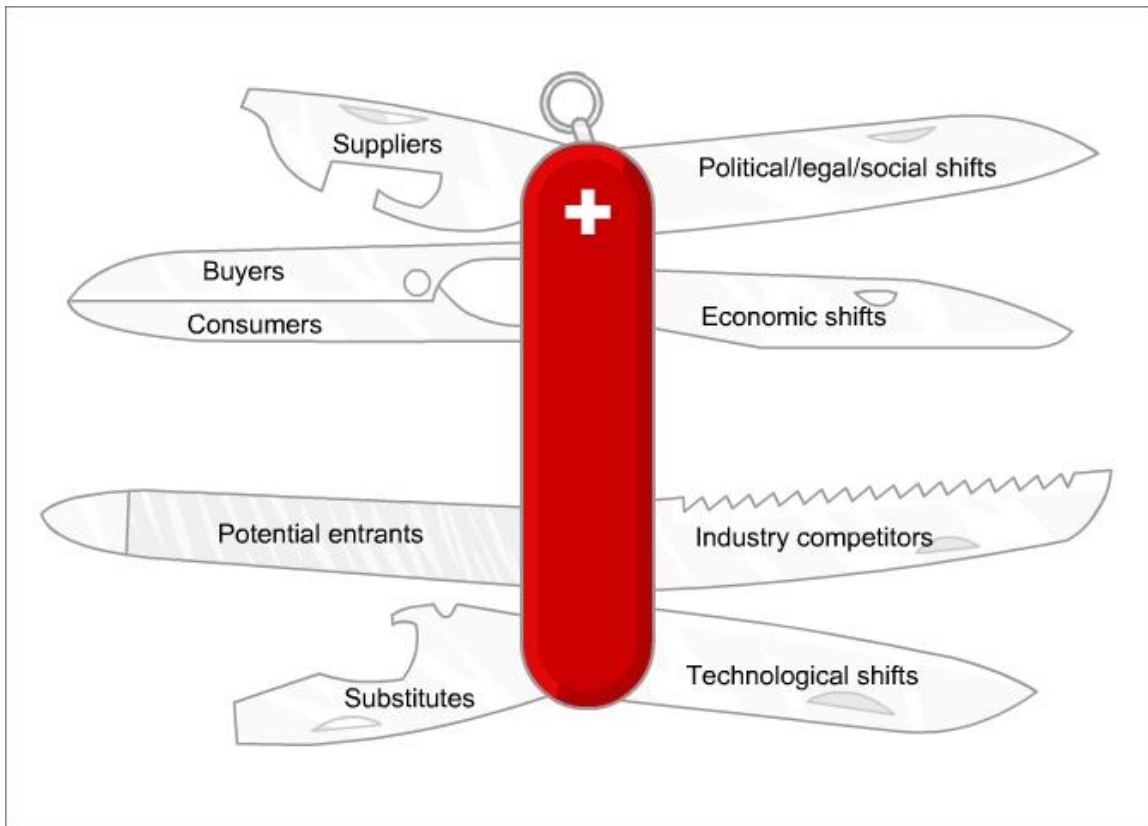
Yes

Answer the questions after your own interpretation of the visualisation.



1. I understand the message that has been signalled through this visualisation.
Yes
No
2. This visualisation signals that
 - a. The value is formed as a combined effort of the players
Yes
No
 - b. The value is realized at the customer level
Yes
No
3. Would this kind of visualisations be appropriate in reports generated for your company?
Yes
No
4. Visualisation would need text to support understanding.
Yes
No

Answer the questions after your own interpretation of the visualisation.



1. I understand the message that has been signalled through this visualisation.

- Yes
- No

2. This visualisation signals that

b. All the components presented in the picture are equal

- Yes
- No

b. The parts presented in the picture are independent components

- Yes
- No

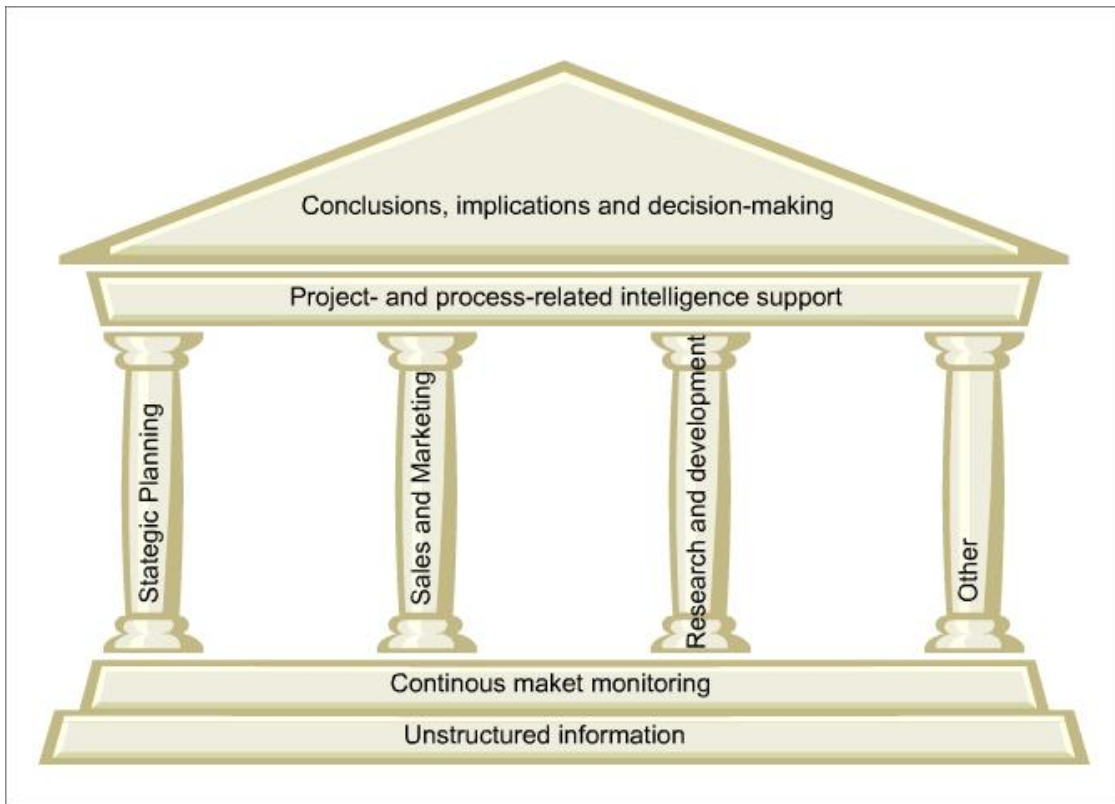
3. Would this kind of visualisations be appropriate in reports generated for your company?

- Yes
- No

4. Visualisation would need text to support understanding.

- Yes
- No

Answer the questions after your own interpretation of the visualisation.



1. I understand the message that has been signalled through this visualisation.
Yes
No
2. This visualisation signals that
 - a. Continuous market monitoring is based on unstructured information
Yes
No
 - b. Conclusions, implications and decision-making are composed of the other functions presented under it
Yes
No
3. Would this kind of visualisations be appropriate in reports generated for your company?
Yes
No
4. Visualisation would need text to support understanding.
Yes
No

Answer the questions after your own interpretation of the visualisation.



1. I understand the message that has been signalled through this visualisation.
Yes
No
2. This visualisation signals that
 - a. one can move from fire-fighter to futurist through different steps
Yes
No
 - b. MI-program is brought into use at the beginners' level
Yes
No
3. Would this kind of visualisations be appropriate in reports generated for your company?
Yes
No
4. Visualisation would need text to support understanding.
Yes
No

Appendix 6. Cover letter

Hei,

Teen tutkimusta tiedon visualisoinnista *Yritys A:n*¹ asiakkaille. Tutkimustuloksia on tarkoitus soveltaa Yritys A:n asiakkailleen tuottamissa raporteissa. Visualisoinnilla voidaan mahdollisesti parantaa raporttien luettavuutta, helpottaa ymmärtämistä sekä lyhentää raporteiden lukuaikaa. Tutkimus on osa Aalto-yliopiston Kauppakorkeakoululle tehtävää lopputyötä.

Yritys A on market intelligence yritys, joka tarjoaa asiakkailleen erilaisia ratkaisuja markkina-analyysiin ja -seurantaan. Yritys A:n asiakkaat Suomessa ovat suomalaisia ja kansainvälisiä suuria liikeyrityksiä, jotka toimivat useilla eri liiketoiminta-aloilla. Yritys A toimittaa asiakkailleen yrityksen päätöksentekoa tukevaa tietoa.

Kyselyyn vastaaminen vie noin 5 minuuttia. Kysely on anonyymi, eikä yksittäistä vastaajaa ja vastauksia pystytä yhdistämään toisiinsa. Kyselyyn voit vastata 28.3. asti. Kiitän arvokkaasta avustanne!

Voitte vastata kyselyyn alla olevan linkin avulla:

https://*****

Jos linkki ei aukea klikkaamalla, kopioikaa se hiiren avulla internetselaimen osoiteriville.

Ystävällisesti
Janika Niskanen

¹ Name has been changed for confidentiality reasons.

Appendix 7. Translation of cover letter

Hi,

I'm conducting a survey on knowledge visualisation among *Company A's*² clients. The survey results are applied in the reports that Company A generates to its clients. The readability of the reports, the easiness of understanding and the time used to read the reports will potentially be improved with the visualisations. The survey is part of master's thesis written for Aalto University School of Economics.

Company A is a market intelligence company offering different solutions for market analysis and market monitoring. Company A's clients in Finland are Finnish and international large enterprises operating in various industries. Company A delivers knowledge that supports decision making to its clients.

Answering takes approximately 5 minutes. The survey is anonymous and the responses can't be linked to individual respondents. The survey is open until 28th March. Thank you for your valuable time!

Please click the link to start the survey.

https://*****

If the link does not work paste this into your browser.

Best regards,
Janika Niskanen

² Name has been changed for confidentiality reasons.