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Identification of knowledge: A research to develop a tool to map the present and required knowledge of Eaton's employees

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Preface

This paper is the final assignment of the Master Business Administration, specialization Human Resource Management, which is carried out at Eaton Industries B.V. located in Hengelo. Eaton has to deal with changes in the workforce, including a high average age, a low inflow and a potentially high outflow of employees. The outflow of employees can cause a loss of knowledge. A low inflow means that Eaton is more dependent on current employees. These changes ensure that it is more important to know what the present knowledge is. In this study a tool is developed to map knowledge of the employees of Eaton, which makes it possible to maintain the knowledge levels and keep knowledge within the organization.

I would like to use this preface to thank a number of people who assisted me in completing my master thesis. First of all, I would like to thank Eaton for the opportunity to perform the thesis at their HR department in Hengelo. In addition, my thanks go out to Bill Vrijenhoek for his supervision during the graduation process. He came up with advices and suggestions, which were valuable to carry out the thesis as well as possible. I would also like to thank the other employees of the HR department of Eaton for their time and effort.

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Management Summary

This research is carried out at the plant of Eaton Industries B.V. located in Hengelo, with about 900 employees. Eaton Industries B.V. focuses on the development, production and selling of products for switching, distributing and protecting energy both low and medium voltage. In other words, the activities of Eaton Industries B.V. are in the field of electrical power energy and technology.

Problem definition

The plant of Eaton Industries B.V. in Hengelo has to deal with changes in the workforce. The most common issues are an aging population within the company; the difficulty to find (young) technically skilled employees; and a natural outflow. The changes are determined based on factual data showing that the average age is 47 years; there is an average inflow of 2,25 %; and an average outflow of 4,64%. A consequence of the low inflow is that Eaton is more dependent on the current employees and their knowledge. The most important issue is the outflow, which can cause a potential loss of knowledge. Therefore, it becomes more important to know what the present knowledge is. Thus, the problem is related to the inflow and outflow of employees, which influence the knowledge level within Eaton. At the moment, there is no tool to map the knowledge of employees. This leads to the following research question: *How can a new tool be developed in order to map the present and required knowledge of the employees of Eaton Industries B.V.?*

Analysis and diagnosis

The analysis and diagnosis part contains a literature review, which is conducted to get more insight in the topic and the related aspects. Two approaches, knowledge management and intellectual capital, are described to decide which aspects are useful for the tool. The main idea of knowledge management is to unlock and use knowledge of employees (Anand & Singh, 2011). It is a process consisting of knowledge creation; knowledge storage and retrieval; knowledge transfer; and knowledge application. The focus of this study is on knowledge mapping, part of knowledge creation, to identify where the knowledge stocks and possible knowledge gaps are located. Intellectual capital is focused on intangible resources, the potential to create value and the growth effect of collective practice (Martín-de Castro et al., 2011). The three core elements of intellectual capital are: human capital, structural capital and relational capital. Human capital is composed of knowledge, skills and expertise of employees. Aspects of structural capital are operating process; organization structure; policies; information systems and databases; culture; and rewards. Relations inside and outside the organization belong to relational capital (Marr, 2008). On the basis of the literature review, it is determined that the identification of knowledge and experiences is central in this research.

Plan of action

The plan of action is dedicated to the design of the tool. Existing tools to map knowledge are discussed to determine whether they have aspects, which can be applied to the new tool. In addition, the specifications of the design are partly based on interviews with HR employees, managers of the front-end departments and the plant manager. The most important requirement is to develop a simple tool, which is easy to use. In advance the target group, the departments of front-end, is determined from which the knowledge is mapped. The intention is that employees indicate their knowledge level, difficulty to transfer knowledge, experience level and difficulty to transfer experiences in relation to knowledge areas. The final result is a function matrix that represents the available and required knowledge and experiences of employees. An addition, the individual matrix also shows how difficult it is to transfer knowledge and experiences of employees.

Intervention and evaluation

The tool is tested at the front-end departments. The knowledge areas for three functions of the target group are established with specific knowledge that is crucial for Eaton. In total, six application engineers, three order manager and three order processing managers fill in the matrix. After the tool is completed the usefulness is partly evaluated with the manager, supervisors and employees of the test phase. The manager and supervisors argue that the tool can add value, because it is a representation of the knowledge and experience levels within the department. However, more value can be created by developing a central system to combine existing systems and where knowledge becomes available to others. The most common remark of employees is that the knowledge areas are too general. Furthermore, the results are evaluated with the supervisors. A few adjustments are made, because the supervisors found that some employees scored lower or higher than expected.

Discussion

The tool results in an overview of knowledge areas; the identification of employees with high knowledge and experience levels; the detection of risks and knowledge gaps; a simple tool to maintain the levels; and a first step in knowledge management. The reflection of the tool has led to the following suggestions: required knowledge can be determined for each knowledge area; the established knowledge areas can be discussed in work meetings; managers can determine the knowledge and experience levels of employees before they complete the matrix; and managers and employees can discuss the scores with each other. It is advisable to test the matrix again taken the suggestions into account. In addition, changes in an organization's environment can ensure that the content of the tool needs to be adjusted. To conclude, it is not a static, but a dynamic tool.

Recommendations

Finally, recommendations are given to Eaton based on the results and evaluation of the conducted research.

- The HR department can begin with the implementation of knowledge management process. Therefore, it is important that they create one vision on knowledge management.
- After the creation of a knowledge management vision the responsibility can be allocated to employees who form a project group. This group can proceed to embed knowledge management in the organization.
- There are practical issues that can influence managers to perform HR activities, such a lack of desire and capacity. HR can convince managers that knowledge management is relevant. Managers can delegate tasks to experienced employees to have more time to work on knowledge management.
- The project group can create commitment among employees to make clear that knowledge management is important.
- Eaton can start with mapping knowledge of key functions. A guideline regarding the numbers of knowledge areas is 10 to 12. This ensures that managers focus on the specific knowledge within an area.
- To store and share knowledge Eaton can make use of a digital system, for example Microsoft SharePoint. The system makes it possible for employees to share information, manage documents and publish reports. The maintenance of the tool can be improved by using SharePoint. It gives employees the possibility to search, change or add information.

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1. Introduction

The first chapter gives a short overview of the company Eaton. There are changes in the workforce of Eaton, including an aging population, a low inflow of qualified employees and a natural outflow. The changes affect the knowledge level within Eaton. It is important to identify available knowledge to keep crucial knowledge within Eaton and to maintain the knowledge levels of employees. However, knowledge of employees is currently not mapped. This is further elaborated in the problem statement, the research goal, the central question, the research questions and the relevance of the research.

1.1 Company background

In the first section the company background is described. The topics discussed are the origin of Eaton Corporation and Eaton Industries, the supply of Eaton and the markets in which Eaton operates. Thereafter, the background of the plant in Hengelo, part of Eaton Industries B.V, is described, since the assignment is performed for this location.

Eaton Corporation

In 1911 Viggo. V. Torbensen and J.O. Eaton started a company named Torbenson Gear and Axle, which was the first step in the creation of Eaton Corporation. The focus of Eaton Corporation is on power management and developing energy efficient solutions for customers. Eaton has become a global leader regarding electrical components; systems and services for power quality; distribution and control; hydraulics components; systems and services for industrial and mobile equipment; aerospace fuel; hydraulic and pneumatic systems for commercial and military use; and truck and automotive drivetrain and powertrain systems for performance, fuel economy and safety. The supply of Eaton can be seen as very diverse. In general, Eaton wants to support the customers in order to cope with the use of energy, which means using energy in a more efficient way. Customers will be supported by Eaton to manage their power, for example customers that need power for their houses, cars or machines. There are about 73.000 employees that work for Eaton worldwide and the products are sold to more than 150 countries, with in 2011 a sales amount of $16 billion. Overall, there are five segments to distinguish, namely: electrical, hydraulics, aerospace, truck and automotive.

Eaton Industries B.V.

Eaton Industries B.V. (Netherlands) is part of the Eaton Corporation and a global industrial manufacturer that produces a wide variety of products. It was founded in 1913 by Floris Hazemeyer who started with his own electrotechnical company in Hengelo. His company, Hanzemeyer N.V., became a member of Holec NV in 1963. In 2003 the activities of Holec NV were transferred to Eaton Corporation. Finally, in 2008 Eaton Industries B.V. was established by a merger between Eaton Holec, Moeller electric (a worldwide supplier of electrical components and industrial control components) and Eaton Power Quality. Eaton Industries B.V. focuses on the development, production and selling of products for switching, distributing and protecting energy on a low and medium voltage level.

The plant of Eaton in Hengelo

The focus of this research is on the plant located in Hengelo, the Netherlands, part of Eaton Industries B.V, with almost 900 employees. The plant of Eaton in Hengelo is active in the field of electrical power technology for more than 100 years. In addition, Eaton works together with electrotechnical installers whose business is the installation of electricity in for example homes or offices. At last, Eaton supplies electrical power products to other industries. Within Eaton Hengelo,

there are six departments: Product Research & Development (R&D); Technology and Production; Service; Marketing and Communication; Human Resources (HR) and Finance.

Eaton is separated into three different regions, namely the American region (US, Canada and South America), the EMEA region (Europe, the Middle East and Africa) and the APAC region (Asia/Pacific). The plant in Hengelo produces for the EMEA region and delivers products to seven different markets. These markets are: energy companies; heavy process and petrochemical industries; industry; health; commercial buildings; residential areas, shops and small offices; and panel building and OEM.

Front-end

The front-end structure of Eaton consists of three main departments: sales country, business unit and order management (plant level). One of the core activities of sales country is analyzing, evaluating, calculating and quoting systems for customers of the countries belonging to the sales organization. The business unit makes quotations for LV (low voltage) systems, MV (medium voltage) systems and Services and manages projects in the offering phase. The plant in Hengelo is part of the business unit department. The central activity of the order management level is the transfer of quotation to order. Overall, there are three sub-activities consisting of customer support; order management; and electrical and mechanical engineering.

1.2 Problem statement

The problem statement is based on interviews with employees of the HR department. Eaton has to deal with changes in the workforce, with a particular consideration for the aging population. This means that there are more elderly employees who leave the organization when they retire. In general, this results in a potential outflow of elderly employees for Eaton, which might lead to a potential loss of 'uncharted' knowledge. Moreover, there can be a natural outflow of employees, which can also cause a loss of knowledge. On the other hand, the hazing process should be taken into account. This involves the decrease of the amount of younger people in the population. A consequence might be that it is more difficult to attract qualified employees that have technical knowledge. This is also the case for Eaton, because there is hardly an inflow of (young) skilled employees. Eaton is more dependent of the current employees with their associated knowledge levels.

Recently there has been a research at Eaton in the context of sustainable participation carried out by Berenschot. The results are relevant for this study, since the data are applicable to the above-mentioned changes. Primarily, the ratio between permanent and temporary employees is 97,9%/2,1%. The average age for Eaton as a whole is 47 years, with an average employment of 21 years (Berenschot, 2011). These numbers can be an indication that there is aging, considering the whole organization. Through a high employment the employees stay longer in the company, so the average age increases.

The inflow and outflow are defined as the percentage of employees that join or leave in comparison with the total amount of employees. The inflow and outflow have been calculated for the years 2010, 2011 and 2012 (appendix 1). The average inflow of technical personnel is 1,07%. It can be assumed, for the entire organization, that there is a lack of technical employees, because of the low average percentage. In addition, the inflow as a whole is also low with an average of 2,25%. Another problem is the outflow of employees, whereby the largest groups that leave are employees who retire (43%) and employees that have another job/function (33%). The average total outflow is

4,64%. It is also remarkable that 110 employees may retire in the next six years. The employees who can flow out mainly belong to the production and sales department (see appendix 2). In general, from an organization-wide perspective Eaton has to deal with a high average age, a low inflow percentage also regarding technical employees and a possible high outflow of elderly people.

The above mentioned changes and situations ensure that it becomes more important for Eaton to know what the current knowledge is and how this knowledge relates to the mission, vision, strategy and objectives of the company. The interviewed employees of the HR department of Eaton indicate that the organization has not a clear view of the available and required knowledge among employees. It can improve the competitive advantage of Eaton, when the right people with the intended knowledge levels are present in the organization. From Eaton the question has come to develop a tool to map the present and the required knowledge. The tool should clarify whether there is sufficient knowledge among the employees of Eaton, also to follow the strategy and achieve the pre-established objectives. It is a relevant topic, since crucial knowledge influences the distinctiveness of a company in relation to their competitors. *It can be concluded that the problem is related to the aging and hazing process, which have an impact on the inflow and outflow of employees and influence the knowledge level within Eaton.*

1.3 Research goal

The research will focus on the development of a tool to map the present and required knowledge, which will be tested at the front-end departments of Eaton Industries B.V. The tool should make it easier for Eaton to gain insight in the existing knowledge levels within the company. It is possible that employees do not have knowledge, which is important to achieve the overall strategy of Eaton. This can lead to gaps between the present and required knowledge. The tool can also be important to retain employees with crucial knowledge. Two perspectives will be examined to find out which elements of these approaches are appropriate to map the knowledge of Eaton's employees.

To map knowledge it must be clear which components are relevant for the tool. This is the reason to include both the knowledge management approach and the intellectual capital approach. Second, the research is about developing a tool for the HR department of Eaton Industries B.V. in Hengelo. The ultimate goal is that managers of other departments can use the tool by themselves. Third, the tool will be tested at the front-end departments, also located at the plant in Hengelo. To test the tool we can verify if it is useful for Eaton and whether any adjustments are necessary. Some of the important requirements from Eaton are: knowledge must be clearly represented in the tool; it is a simple maintenance-friendly tool; and the tool can be used by managers at a decentralized level. Eaton's perspective is that the tool makes it easier to get a complete overview of the knowledge available at the employees. *Overall, the goal of this study is to develop a useful tool to map present and required knowledge, which is necessary for Eaton to achieve their strategy.*

1.4 Central question and research questions

This study is dedicated to the development of a new tool to map the present and required knowledge of the employees of Eaton Industries B.V., to identify employees that are crucial for the organization. The required knowledge is related to the mission, vision, strategy and objectives of Eaton. The intention is that the tool can contribute to the prevention of a potential loss of knowledge when employees leave the organization and can also be used to maintain the knowledge levels of

employees. Once the tool is developed, it will be tested as a 'first' pilot at the departments of front-end. This has resulted in the following central research question:

How can a new tool be developed in order to map the present and required knowledge of the employees of Eaton Industries B.V.?

There are six research questions formulated, which makes it possible to answer the central question. Below, the research questions are described.

1: How is knowledge defined in the literature?
2: What is meant by knowledge management, knowledge mapping and intellectual capital?
3:Which elements of knowledge management and/or intellectual capital are suitable for knowledge mapping?
4: Which methods or tools are described in the literature to map knowledge?
5: What are the requirements from Eaton regarding the design of the tool?
6: How can the tool be tested at the departments belonging to the front-end structure of Eaton Industries B.V. and what are the results?

Knowledge management and intellectual capital are taken into account, because these approaches focus both on knowledge, which is the central topic of this research. Knowledge management can be defined as *'the explicit and systematic management of vital knowledge and its associated processes of creating, gathering, organizing, diffusion, use and exploitation. It requires turning personal knowledge into corporate knowledge that can be widely shared throughout an organization and appropriately applied'* (Anand & Singh, 2011, p. 932). It is a process to make knowledge of individuals accessible, allowing employees to use available knowledge and share it with others. Hsu and Fang (2009) define intellectual capital as '*the total capabilities, knowledge, culture, strategy, process, intellectual property, and relational networks of a company that create value or competitive advantages and help a company achieve its goals'* (p. 665). The intellectual capital approach is more about assets that contain knowledge. In chapter 2, knowledge management and intellectual capital are further described.

1.5 Academic relevance

Knowledge is an important production factor, which can be seen as a strategic resource, to create competitive advantage for a company. Therefore, identifying and representing knowledge is an essential part of knowledge management (Kim, Suh & Hwang, 2003). Another approach included in this research is intellectual capital, which has also potential to create value and manage a sustainable competitive advantage (Petty & Guthrie, 2000). From these approaches it will be examined how to map knowledge. In the literature, different methods are mentioned to map knowledge, for instance yellow paging or process knowledge mapping (Jafari, Akhavan, Bourouni & Amiri, 2009). Most of the techniques for knowledge mapping consist of several consecutive steps that a company must follow to create a knowledge map. An example is the identification method of Boersma (2002), which contains eight steps before a knowledge map is created. This means that the knowledge mapping process may take a lot of time for companies. Overall, organizations may have problems to map knowledge by using existing complex tools and techniques. In addition, the representation of results might be not clear enough (e.g. Liu, Li & Lv, 2009; Watthananon & Mingkhwan, 2012). Therefore, this study can contribute to the existing literature about knowledge mapping tools, because this research focuses on the development of a simple tool, which is easy to use.

1.6 Practical relevance

As mentioned before, both knowledge and intellectual capital can provide a competitive advantage for a company. On the other hand companies can follow others by delivering the same quality or price. Therefore, ideas and creativity of employees within an organization can be used to develop new products with a new level of quality or with other prices (Davenport & Prusak, 1998). According to van Daal, de Haas and Weggeman (1998) the only source for a permanent competitive advantage is knowledge. The question that arises from companies is how knowledge can be mapped. Eaton Industries B.V. has come up with the question to develop a simple tool where present and required knowledge are represented and which is easy to use. The new tool might be valuable for Eaton Industries B.V., because knowledge is an essential production factor. Eaton Industries B.V. can maintain their competitive advantage with the knowledge of employees. The first step is to map the knowledge to determine what the position of the organization is in the current situation. In addition, it gives an idea about the required knowledge of Eaton Industries B.V. to meet their strategy and goals. The new knowledge mapping tool might also be valuable for other companies, since it provides a solution to map knowledge in a simple way and keeping knowledge up to date should be made easier. It must be possible to map knowledge, without using difficult analyzes or techniques.

2. Literature review

In chapter two a literature review is conducted to search for suitable theories, which can be used to design the tool. First of all, the concept of knowledge is explained, since the purpose is to map knowledge. Second, the approach of knowledge management is discussed. Lastly, a different approach is described, namely intellectual capital that might also have appropriate elements for knowledge mapping.

2.1 Data, information and knowledge

A common distinction made in the academic literature refers to data, information and knowledge. We have to know what knowledge is and which different types there are to map the right knowledge.

Data

A definition of data is given by Davenport and Prusak (1998) which is *'a set of discrete, objective facts about events'* (p. 2). Alavi and Leidner (2001) define data as *'raw numbers and facts'* (p.109). These definitions are rather limited to facts and/or numbers. Weggeman (1997) defines data as *'symbolic representations of numbers, quantities, parameters or facts'* (p. 30). This definition is also related to the others, since the elements used by the authors to describe data are both facts and numbers. However, Weggeman's definition gives the most complete description of data, because quantities and parameters can also be data. In addition, data itself does not say much to people; it is more about what people do with the given data. Bellinger, Castro and Mills (2004) state that data is something that exists in different forms, which might be useful or not, but it has not a specific meaning.

Information

According to Davenport and Prusak (1998) information is *'a message, usually in the form of a document or an audible or visible communication'* (p. 3). The authors argue that information can have an effect or change on the behavior of the receivers of the message. Boersma (2002) examines this further and also describes information as a message from a sender to a receiver. When people give meaning to data, it becomes information. In other words, people interpret and manipulate the data, which ensures that data is transformed into information. To summarize, data is very important by the process of creating information. Though, it should be noted that giving meaning to certain data can be useful, but it is not self-evident (Bellinger et al., 2004).

Knowledge

A first description of knowledge is from Nooteboom (1996) who compiled the following definition *'knowledge is a meaningfully ordered stock of information (interpreted data), and understanding, plus ability to transform it into actions (skills), which yields performance'* (p. 8). By decomposing this definition, it is noticeable that performance and outcome of executing tasks are central. In first instance, knowledge is related to understand a situation. The second part of the definition is more about the skills of people, which is associated with transforming insight into action. This process results in a certain performance (Boersma, 2002). The central aspects of this definition are information and skills, but experience is also part of knowledge. The distinctive elements of knowledge are not complete clear with regard to this definition.

Davenport and Prusak (1998) come up with a 'working' definition of knowledge *'Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices and norms'* (p. 5). From this definition, knowledge is a combination of several components, such as the experiences and values of individuals. It is something that exists in the mind of peoples, which makes it complex, unpredictable and difficult to capture. The main focus is on implicit knowledge and the difference with explicit knowledge is not entirely clear.

The definition given by van Daal et al. (1998) is more complete, because it clearly indicates the elements which are related to knowledge. There is also a proper distinction between explicit and implicit knowledge. In addition, the different characteristics of knowledge mentioned in the previous definitions come together in the description of van Daal et al. (1998). They define knowledge as *'the capacity that enables someone to perform a particular task'* (p. 256). This definition of knowledge contains different elements, namely information, experience, skills and attitude. The knowledge definition is also represented in the formula K= I*ESA. The formula will be explained in more detail, since it is a common definition of knowledge used in the Netherlands and in other literature (Boersma, 2002). Information is related to explicit knowledge, which can be codified and further elaborated in for instance documents, theories and manuals. Experience, skills and attitude are implicit knowledge. *Experiences* are personal and can be divided into feelings, associations, fantasies and assumptions. *Skills* represent traditional skills, analytical and communication skills, spatial awareness etc. *Attitude* is also personal and is characterized by norms, values and basic assumptions that determine the actions of a person in a given situation (van Daal et al., 1998). Overall, the core of Weggeman's definition is the functioning employee who performs a certain task.

Alavi and Leidner (2001) make a comparison between information and knowledge. Knowledge is in the minds of people, it is personalized information. At the time that knowledge is processed to graphics, text or words, it is transformed to information. According to Anand and Singh (2011) there are three main characteristics related to knowledge. First, it is about a state of knowing, to be familiar with facts, methods, principles and techniques. Second, knowledge is a capacity for action to understand and apply the facts, methods, principles and techniques. Third, knowledge refers to codified, captured and accumulated facts, methods, principles and techniques.

2.1.1 Knowledge classifications

According to Boersma (2002) knowledge is divided into two dimensions: explicit and implicit knowledge. The author made this distinction, since people are not always aware of the knowledge they use in practice. Explicit knowledge can be expressed in a certain language and is therefore easy to transmit to other people. Implicit knowledge is knowledge that is widely used, but it is difficult to make implicit knowledge explicit. People often take actions based on their experiences and skills. This approach is relatively broad and it does not address the content of explicit and implicit knowledge. An addition to clarify the difference is from van Daal et al. (1998) who also describe explicit and implicit knowledge, which is related to the formula K= I*ESA. The differences are shown in table 1:

Explicit knowledge (Information)	Implicit knowledge (Experiences, Skills and Attitudes)
Codified knowledge	Tacit knowledge
Information formulated in theories, formulas, procedures, manuals etc.	Experience, skills and attitude
Transfer through education	Shared through demonstration
Attainable through study in teaching process	Attainable through imitation in socialization process
Cannot be used as power	Can be used as power

Table 1: Explicit versus implicit knowledge (van Daal et al., 1998, p.256)

Another approach is described by Alavi and Leidner (2001), who divided tacit knowledge into a technical and a cognitive element. The technical element contains the know-how and skills of people used in a certain context. The cognitive element is related to mental maps, beliefs, standards and perspectives that individuals have. Explicit knowledge is general knowledge that is codified and communicated by using own languages. To make it more specific, explicit knowledge contains documented processes, directives, standards, or patents. Tacit knowledge is knowledge that exists in the minds of people and is related to experiences and expertise. The distinction made by Alavi and Leidner (2001) is included to show that different approaches of implicit and explicit knowledge can be used, because the reasoning is largely the same. An organization should focus on their most important assets, which is not the product itself, but the knowledge of people to produce these products (Dayan & Evans, 2006). It is clear that explicit knowledge can be easily transferred, since it is formal and systematic. On the other hand sharing tacit knowledge is more difficult, since it is hard to formalize (Nonaka, 1991). Overall, the reason to classify knowledge in this manner is that every employee in an organization has both implicit and explicit knowledge.

In the previous part, the implicit-explicit dimension is explained, but that is not the only classification of knowledge types. There are authors who divide knowledge into different types (e.g. Alavi & Leidner, 2001; Eppler, 2001; Boersma, 2002). The knowledge types described by Alavi and Leidner (2001) are: declarative (know-about), procedural (know-how), causal (know-why), conditional (know-when) and relational (know-with). An addition is given by Eppler (2001), who distinguishes heuristic knowledge (know-how), experiences (know-why) and factual knowledge (know-what).

Factual or declarative knowledge (know-what, know-about) contains data stored in documents or databases entries. Procedural knowledge (know-how) can be related to experts, processes or applications (Eppler, 2001). This type of knowledge is about certain actions, which are carried out by using prescribed steps to achieve a pre-established defined target. Next to the facts and procedures, people use interpretive knowledge. People view and interpret situations on feasibility, where social-psychological aspects play a role. The last type is background knowledge or meta-knowledge (know-when, know-why), which is focused on the explanation of a process (Boersma, 2002).

Boersma (2002) makes also another distinction between different types of knowledge, including required and crucial knowledge. The former is related to companies that need knowledge which is necessary to survive and to continue with the proceedings. It may involve knowledge for the production, marketing or sales. Thus, required knowledge is about all the types of knowledge that are essential for a company to operate. Through crucial knowledge of employees a company can be considered as unique. Crucial knowledge belongs to core competences, which makes it possible for a

company to distinguish themselves from competitors. Developments in the business environment might cause the need of companies to attract new crucial knowledge and existing knowledge will be repelled.

Overall, there are different perceptions to divide knowledge into several types. The focus in this research is the explicit-implicit dimension, because the other classifications do not completely cover implicit knowledge. It is perhaps a more general classification, but important to recognize is that people have knowledge, which is expressed in words or reports and knowledge that is personal, such as experiences. In addition, the required and crucial knowledge distinction will be taken into account, since these types are part of the process of knowledge mapping in this research.

2.1.2 Knowledge management

Before describing the concept of knowledge mapping the approach of knowledge management is discussed. In recent years organizations are more concerned with knowledge management to improve the access and storage of information with regard to the employees (Watthananona & Mingkhwan, 2012). According to Quintas, Lefrere and Jones (1997) knowledge management is *'the process of continually managing knowledge of all kinds to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities'* (p. 387). The definition provides the opportunity to distinguish different types of knowledge. It also focuses on the development of action-oriented goals for managers, such as monitoring management activities in terms of knowledge. An important point to recognize is that the related activities, for example to ensure that all the employees know where they can find the available knowledge, have an effect on all the organizational levels and functions (Quintas et al., 1997). The definition has also a downside, since it is about managing knowledge of all kinds, which is very broad.

Dayan and Evans (2006) state that knowledge management is *'the systematic effort to capture, store, retrieve, reuse, create, transfer and share knowledge assets within an organization, in a measurable way completely integrated in its operational and business goals, in order to maximize innovation and competitive advantage'* (p. 70). The authors define four specific processes of knowledge management consisting of knowledge creation; knowledge capture and documentation; knowledge retrieval for reuse; and knowledge sharing. The processes can be measured at three levels: the performance level (the need for the KM process and what is achieved), the throughput level (monitor the KM activities to conclude that it is efficient or not) and the business result (the purpose of KM, whether it is related to the goals of a company). From this definition, it is easier to determine what the focus is, namely knowledge assets. On the other hand, it is not clear what these knowledge assets are.

King (2009) defines knowledge management as follows *'knowledge management is the planning, organizing, motivating, and controlling of people, processes and systems in the organization to ensure that its knowledge-related assets are improved and effectively employed'* (p. 4). The knowledge assets consist of printed documents (patents and manuals); electronic repositories (database); knowledge of employees about how to perform the job in the right manner; knowledge of teams; and knowledge that is embedded in the products, processes and relationships of the organization (King, 2009). This explanation gives a complete overview of the related components of knowledge management. It is not only about knowledge of the employees, but also about the network of people and stored knowledge in the form of documents and databases.

The above definitions of knowledge management have a perspective based on intellectual capital or knowledge assets. These definitions describe the management of all knowledge-related assets, such as patents and networks, which is a broad approach. The focus in this research is not on knowledge assets, but the knowledge of employees is central. To get a better overview of knowledge management definitions with other perspectives are included. Alavi and Leidner (1999) refer to knowledge management as *'a systematic and organizationally specified process of acquiring, organizing and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work'* (p. 6). The authors state that '*information which is actively processed in the mind of an individual through a process of reflection, enlightenment, and learning can be useful*' (p.6). The core of this definition is related to the implicit and explicit knowledge of the employees. A side note is that there is too little attention paid to the process of knowledge management and the belonging steps. Knowledge management is more than acquiring, organizing and communicating of knowledge.

An addition to the previous definition is from Anand and Singh (2011). They define knowledge management as *'the explicit and systematic management of vital knowledge and its associated processes of creating, gathering, organizing, diffusion, use and exploitation. It requires turning personal knowledge into corporate knowledge that can be widely shared throughout an organization and appropriately applied'* (p. 932). It is a complete definition mainly because the process of knowledge management is clearly explained. This definition is also valuable, since it addresses the transition of personal knowledge into organizational knowledge. A missing aspect is that both implicit and explicit knowledge are part of knowledge management. Therefore, the two definitions are combined to provide a complete representation of the approach of knowledge management used in this study. Overall, knowledge management is about managing knowledge of people and supports them to share the knowledge, which creates value for products and services.

Boersma (2002) distinguishes three main tasks within knowledge management, which are asset management, access management and accruement management. Asset management, either inventory, analyze, plan and manage knowledge, is related to knowledge assets. The first purpose of asset management is knowledge mapping, with the creation of a knowledge map as result. The emphasis is on knowledge assets, since these are qualified sources of knowledge, which offers possibilities to solve problems in such a way that it increases the success of an organization (Eppler, 2001). Access management is related to accessibility of knowledge, knowledge sharing and learning. The third task, accruement management, is more about the development of new knowledge. A more appropriate approach is the knowledge value chain developed by Weggeman (1997), because it focuses on knowledge of employees instead of knowledge assets. The knowledge value chain comprises the following activities: determine the required knowledge, given the strategy of a company; inventory of the present knowledge; knowledge development; knowledge sharing; applying knowledge and evaluating knowledge. As mentioned, the current research is dedicated to the required and present knowledge and how it can be mapped. Therefore, the activities of knowledge management will not be described extensively, except the knowledge mapping process (part of the knowledge development stage).

Generally, knowledge management includes four main processes, namely: creation, storage/retrieval, transfer and application (Alavi & Leidner, 2001; Anand & Singh, 2011). The process of knowledge creation consists of the identification, capturing, acquisition and creation of

knowledge. Knowledge retrieval is the transformation process of tacit knowledge into a more codified and understandable form, which can be stored in repositories. The focus of knowledge transfer or dissemination is sharing explicit and implicit knowledge to all the employees within an organization. Finally, knowledge application is the process of using knowledge in the organization.

To summarize, knowledge management can be seen as process that consists of several tasks. There is not a single definition of knowledge management, but the main reasoning is to unlock and use knowledge of individuals, which results in an organizational resource (Anand & Singh, 2011). The tasks which can be divided are: identification, creation, development, sharing, transformation, retention, renovation, diffusion and application of knowledge use (Lloria, 2008; King, 2009). In general, the main purposes to manage knowledge are: discover and develop new opportunities, increase the value for customers and retain or improve the competitive advantage (Lloria, 2008). In addition, it is accepted that well established knowledge management increases the efficiency and performance of companies (Watthananona & Mingkhwan, 2012). To create useful knowledge and make it available for the people who use the knowledge will affect the performance of a company in a positive way (King, 2009).

2.2 Knowledge mapping

This section is devoted to knowledge mapping, because it is the first step in knowledge management and is applied in this research. Knowledge mapping is a term often mentioned in the literature with a variety of definitions. Authors recognize the importance of knowledge mapping within the domain of knowledge management (Eppler, 2001; Wexler, 2001). According to Vail (1999) (cited by Burnett, Illingworth & Webster, 2004) knowledge mapping is *'the process of associating items of information or knowledge (preferably visual) in such a way that the mapping itself creates additional knowledge.. The mapping process often creates intellectual capital value through the creation of new knowledge from discovering previously unknown relationships or gaps in expected ones*' (p. 26). This is more about creating additional knowledge or intellectual capital value, which is less related to mapping knowledge of employees. Wexler (2001) describes knowledge mapping more in terms of a communication tool between map makers and map users in the form of texts, stories, models, numbers or symbols to represent important knowledge of the company. However, it is more focused on intellectual capital instead of the identification of knowledge that employees have. Another common definition of knowledge mapping is from Speel, Shadbolt, de Vries, van Dam & O'Hara (1999) (cited by Jafari et al., 2009). The authors define knowledge mapping as *'the process, methods, and tools for analyzing knowledge areas in order to discover features or meaning and to visualize them in a comprehensive, transparent form such that the business-relevant features are clearly highlighted'* (p. 2). This is more applicable for this research, since knowledge areas can be used to discover knowledge features. In other words, the principle of knowledge mapping is the identification of knowledge within an organization to find out where knowledge resides (Egbu & Suresh, 2008).

It is common that organizations have a large amount of knowledge resources, including extensive networks, and it can take a lot of time and effort for employees to search and find the right knowledge (Liu, Li, & Lv, 2009). Therefore, the result of knowledge mapping is a tool where managers or employees can find the knowledge that these people need, which is also known as a knowledge map (Chan & Liebowitz, 2006). The definition of a knowledge map given by Davenport and Prusak (1998) is *'a knowledge map- whether it is an actual map, a knowledge ''Yellow Pages,'' or a cleverly*

constructed database- points to knowledge but doesn't contain it. It is a guide, not a repository' (p. 72). An organization should identify important knowledge and represent it by using lists or pictures. It shows employees in the organization where they can find the needed expertise. However, it is a relatively vague definition, because it discusses different knowledge maps types which are not further explained. Grey (1999) has a different, but common definition of a knowledge map, namely '*a knowledge map is a navigation aid to explicit and implicit knowledge, illustrating how knowledge flows throughout an organization'* (p. 36). Here, the knowledge flows are involved, but this is not always part of knowledge mapping. The most important activity is to identify what knowledge is available within an organization. A simpler definition described by Egbu and Suresh (2008) is '*a knowledge map is a 'picture' of what exists in an organization or a 'network' of where it is located'* (p. 49). This definition is consistent with the purpose of the study. The link can be established between the knowledge stock of the company and the gaps that have to be supplemented with 'new knowledge sources'. The reason to develop a knowledge map is to ensure that employees, teams or business units comprehend and use the present knowledge in a company, making it a kind of supporting tool (Eppler, 2001; Egbu & Suresh, 2008). It also provides a better understanding for a company as a whole to know what knowledge is available among the employees.

A point of interest is that the previous definitions of knowledge maps do not describe different knowledge map types in detail. Several approaches are taken into account to obtain a complete overview of knowledge map types. The types will be briefly explained, because it is important to determine which of the knowledge map types can be applied in this research. Eppler (2001) uses a different structure, since the author defines knowledge maps as '*graphic directories of knowledge sources (i.e., experts), -assets (i.e. core competencies), -structures (i.e., skill domains), -applications (i.e. specific contexts in which knowledge has to be applied, such as a process), or –development stages (phases of knowledge development or learning paths)* (p. 2). It becomes clear that the author refers to five types of knowledge maps.

Knowledge source maps are about structuring the experts in a company. A company can add search options related to for instance the domain of experts, regional distribution or seniority. In simple words, it is about identifying the units or persons which keep the knowledge (Watthananon & Mingkhwan, 2012). Knowledge asset maps are a kind of 'balance sheets' wherein the available intellectual capital of an organization is represented. In other words, it is the knowledge stock of employees, teams, units or even the whole organization. Knowledge structure maps are an overview of expert domains and the parts of these areas that are related to each other. Knowledge application maps give an idea about which knowledge is needed and must be applied during a certain stage of a process or in specific circumstances. Knowledge development maps can be seen as 'roadmaps' for developing competences. This can be competences of individuals, teams or units of the organization (Eppler, 2001).

Novins (1997) (cited by Eppler, 2006) has a different perception and distinguishes three other types of knowledge maps, specifically pointer models, linkage models and solution models. Pointer models are approximately the same as knowledge source maps. Mapping the knowledge of experts is the central activity. Linkage models will be supplemented with meta-information to the sources, which means data over data, to give a more visual overview to people about how knowledge can be used (e.g. linking knowledge to a process). Solution models are a combination of descriptive and

prescriptive components. The knowledge areas within an organization will be related to business problems.

Eppler (2006) mentioned in his research a minimal requirement to create a knowledge map, which is 'a *graphic overview and reference of knowledge-related content that serves a knowledge management related purpose'* (p. 3). Other requirements for a knowledge map are: effectively reducing of a large amount of knowledge in a number of categories and including the characteristics of enterprise processes, which are complete to the knowledge workers (Liu et al., 2009). Eppler (2006) gives a summary of six knowledge maps related to the knowledge management purpose, which will be shortly explained. It is partly consistent with the knowledge types mentioned above, but the intention is to find out what the purpose of the tool is in this research. The types described by Eppler (2006) are:

- Knowledge creation maps: show the steps that have to be taken to develop a competence or create new knowledge.
- Knowledge assessment or audit maps: represent the evaluation of knowledge assets by using graphical forms.
- Knowledge identification maps: provide a graphic overview of knowledge assets and indicate the locations where it resides.
- Knowledge acquisition map/ learning maps: consisting of learning overview maps, learning content structure maps and learning reviewing maps.
- Knowledge transfer or communication maps: illustrate the flow of knowledge, i.e. who transfers knowledge to whom.
- Knowledge marketing maps: can be used to signal competence to the public in a certain domain.

In general, there are several types of knowledge maps with their own purpose. In this case the most appropriate type is a knowledge source map, because the aim is to find out where knowledge is available. This also means that employees with crucial knowledge can be discovered, i.e. the experts of the organization.

2.3 Intellectual capital approach

The previous section describes knowledge management as approach to identify knowledge within an organization, which can result in a knowledge map. In the next section intellectual capital and the belonging aspects are discussed, because it can contain elements that are useful to map knowledge. There is also a comparison between knowledge management and intellectual capital to determine which elements of these approaches can be included in current research.

2.3.1 Intellectual capital

The first step is to define intellectual capital with the associated aspects. There are many different definitions of intellectual capital, making it difficult to provide a definition which covers all aspects of intellectual capital. A commonly used definition is from Stewart (1997) who defines intellectual capital as *'the sum of everything everybody in a company knows that gives it a competitive edge'* (p. ix). He further defines it as *'intellectual material-knowledge, information, intellectual property, experience- that can be put to use to create wealth'* (p. x). From this perspective it must be recognized that there is much present capital within an organization. Youndt, Subramaniam and Snell (2004) focus on the definition of Stewart (1997) by splitting it into two aspects. The first element is about the sum of knowledge, which means that knowledge at different levels comes from inside and

outside the organization and are related to intellectual capital. Second, intellectual capital can generate a competitive advantage by using knowledge.

Other frequently mentioned definitions of intellectual capital come from Roos, Roos, Dragonetti and Edvinsson (1997) who refer to *'the sum of knowledge of its members and the practical translation of this knowledge, that is brands, trademarks and processes'* (p. 27) and Edvinsson (1997) who defines intellectual capital as '*the possession of knowledge, applied experience, organizational technology, customer relationships and professional skills that provide a competitive edge in the market' (*p.368). The above definitions are included, because they are regularly found in the literature. The definitions of Stewart (1997) and Roos et al. (1997) are broad with regard to what intellectual capital includes. Edvinsson (1997) gives a more specific definition, but intellectual capital can contribute to more than just the competitive advantage of an organization.

The previous definitions are relatively old, which does not mean that they are useless, but more recent definitions will also be taken into account. Roos, Pike and Fernström (2005) see intellectual capital as *'all nonmonetary and nonphysical resources that are fully or partly controlled by the organization and that contributes to the organization's value creation'* (p. 19). From the standpoint of the authors resources that contribute to an organization's potential to create value are also known as intellectual capital. An addition to the previous definition is from Marr (2008) who defines intellectual capital as follows *'intellectual capital includes all non-tangible resources that (a) are attributed to an organization, and (b) contribute to the delivery of the organization's value proposition'* (p. 5). These definitions are also too broad and do not elaborate on the aspects that are part of intellectual capital. Besides, the authors describe value creation as contribution, while competitive advantage is omitted.

According to Hsu and Fang (2009) intellectual capital is '*the total capabilities, knowledge, culture, strategy, process, intellectual property, and relational networks of a company that create value or competitive advantages and help a company achieve its goals'* (p. 665). This is a complete and specific explanation of intellectual capital, whereby knowledge is separated from other aspects. Furthermore, intellectual capital can provide both value creation and competitive advantage.

Overall, the definitions vary in detail, but there are some broad characteristics that correspond with each other. This involves the use of collective knowledge in a productive way with the aim of creating value for the organization (Dean & Kretschmer, 2007). Martín-de Castro, Delgado-Verde, López-Sáez and Navas-López (2011) are more specific and describe that intellectual capital includes *'the stocks or funds of knowledge, intangible assets, and ultimately intangible resources and capabilities, which allow for the development of basic business processes of organizations, enabling the achievement of competitive advantages'* (p. 650). To make it simpler, three general characteristics of intellectual capital are: its intangibility, its potential to create value and the growth effect of collective practice and synergies (Martín-de Castro et al., 2011). A drawback is that the authors do not indicate to what extent intangibility is applicable to all aspects of intellectual capital.

Now, more insight is obtained with regard to the definitions of intellectual capital, the related elements are discussed in order to clarify the content of intellectual capital. Edvinsson (1997) divides intellectual capital into two main components, human capital and structural capital, whereby the last mentioned consists of several sub-elements. The same distinction is made by the Organisation for Economic Co-operation and Development (OECD) (cited by Petty & Guthrie, 2000), though they

describe structural capital as organizational capital. Another approach describes the following categories: external (customer-related) capital, internal (structural) capital, and human capital (Roos et al., 1997).

Lim and Dallimore (2004) assume two categories, corporate competencies and corporate relationships, each consisting of four components. The corporate competencies are human capital, corporate capital, business capital and functional capital. The corporate relationships are customer capital, supplier capital, alliance capital and investor capital (p. 185). However, the most defined subcategories of intellectual capital are human, structural and relational capital (e.g. Cabrita & Bontis, 2008; Hsu & Fang, 2009; Martín-de Castro et al., 2011; Stewart, 1998; Youndt et al., 2004). This is the reason to describe these categories in detail.

Human capital

The human capital aspect denotes to knowledge, know-how, skills and expertise of the employees within a company. By applying and using the knowledge employees can increase the value of an organization. Therefore, it is important that employees have an open attitude so that the knowledge of them can be exploited (Zhou & Fink, 2003). It refers to both implicit and explicit knowledge that employees have, which is valuable for the company, including values, attitudes and know-how. Based on the literature review of Martín-de Castro et al. (2011), there are three specific dimensions of human capital with associated variables: *knowledge* (formal education, specific training, experience and personal development), *abilities* (individual learning, collaboration team work, communication and leadership) and *behaviors* (feeling of belonging and commitment, self-motivation, job satisfaction, friendship, flexibility and creativity) (p. 655). In other words, it is about the knowledge of employees, which might be related to education and followed training; employees' experiences and skills; and behaviors of employees, which are central to perform their job. A remark is that an organization cannot own the human capital of employees. This means that human capital is not only focused on individuals, but also the collective knowledge and skills of the workers are part of human capital (Stewart, 1998).

Structural capital (also known as organizational capital)

Structural capital comprises technological and organizational capital, which also covers the distinction made by Edvinsson (1997). Technological capital is combining organizational knowledge in such a manner that it is linked to the development of the technical systems, new products and services; increase the efficiency of the production process; and the encouragement of technological innovations. Martín-de Castro et al. (2011) state that technological capital has three components: the process, exertion and time related to research and development; the technological infrastructure; and the intellectual property of an organization. The authors also describe organizational capital which includes: the culture (e.g. norms and values) of an organization; the ability to use information systems and telecommunications; and the overall structure of the company. Cabrita and Bontis (2008) argue that structural capital involves non-human assets, for example management information systems, databases and procedures. This is a very broad description of the structural capital concept. Zhou and Fink, (2003) give a more understandable explanation, which refers to dealing with environmental challenges. Examples related to organizational capital are intellectual property (patents, copyrights, trademarks, etc.), the knowledge culture and information systems. To conclude, structural capital delivers tools and systems to preserve, develop and transfer knowledge through the value chain.

Relational capital (also known as social capital)

Relational capital consists of the relationships of an organization with their customers, suppliers and competitors (Cabrita & Grilo, 2012). It includes the knowledge, which is bound to the relationships with all the stakeholders, who have influence on a company's existence (Cabrita & Bontis, 2008). Martínez-Torres (2006) defines relational capital in a concise and clear manner, namely *'the relationships that an organization has with its clients/customers and environment'* (p. 617). Thus, relational capital is the knowledge embedded in the entire value chain of a company. It is not just the relationships within an organization, but also the clients, suppliers and other people or companies from outside play a significant role.

Summarizing, the literature review has shown that there are three core elements of intellectual capital: human capital, structural capital and relational capital. Human capital contains the skills, competences, attitudes and know-how of employees. Structural capital includes the operating process; the organization's structure; the policies, information systems and databases; leadership; the company's culture; and the reward system. Relational capital focuses on the relationships inside and outside an organization. This may relate to employees, customers, suppliers, alliance partners, creditors etc. For a full understanding of intellectual capital and the subcategories, see figure 1 (Marr, 2008, p. 6).

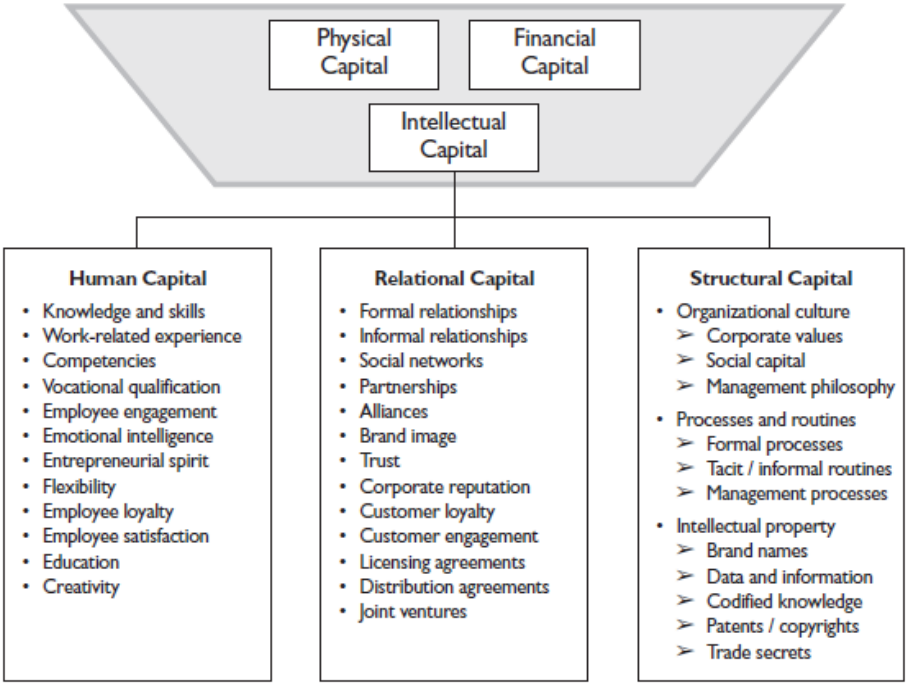


Figure 1: Classification of intellectual capital (Marr, 2008, p. 6)

2.3.2 Process of intellectual capital management

The elements of intellectual capital are clear, but it is also important to know something about the process of intellectual capital, which might be applicable to map knowledge. The Meritum (2002) guideline consists of a framework with three steps to manage intellectual capital in an effective way. These steps are: identifying intellectual capital that is essential to maintain competitive advantage (the strategic goals of an organization should be taken into account); measuring the intellectual capital; and take actions to increase the value of the intellectual capital. The mentioned steps give an

organization the possibility to create an intellectual capital report. The guideline is not very detailed, since it only describes a kind of roadmap of steps to manage intellectual capital, which causes a shortcoming of substantive information. Kim, Kumar and Kumar (2009) recommend a model for intellectual capital management based on the ISO 9001 quality management system. The authors describe the following steps: get top management involved to identify the needs of customers; develop the goals of intellectual capital management and make a plan to put it into practice; identify the suitable resources to implement intellectual capital management; develop criteria to measure intellectual capital; measure and monitor changes in the intellectual capital value; share the results with the customers inside and outside the organization; and continuous improvement with regard to the value of intellectual capital. A limitation of this framework is that the focus is only on customers' needs. In addition, it might be useful for ISO 9001 certified companies, but not for other organizations. Marr (2008) emphasizes five steps, which need to be taken for a successful management of the intellectual capital. It all starts with the identification of an organization's intellectual capital. Methods to identify intellectual capital are interviews, workshops or surveys. After the identification the value of intellectual capital will be determined, since not every component has the same value for the organization. The second step is mapping the intellectual capital value drivers, which results in a value creation map. There are three components in the map, namely the value propositions, the core activities and the value drivers. After the identification and mapping phase, an organization can start with the measurement of the intellectual capital. Step four is using the information of the measurements to evaluate the performance and apply the information in the decision making process. The last step is to develop a report with the results, including the intellectual capital, which can be shared with internal and external stakeholders. This is a more thorough description of steps that can be taken to manage intellectual capital. Generally, the intellectual capital process consists of three core activities: identify, measure and improve intellectual capital (Kim et al., 2009).

2.3.3 Knowledge management and intellectual capital

In the previous sections the approaches of knowledge management and intellectual capital are explained in detail. In this part of the literature review a comparison is made to determine which aspects of these approaches are suitable to map the knowledge of employees. According to Wiig (1997) intellectual capital management and knowledge management are different with regard to the goals and scopes. On the other hand, both are broad, multi-dimensional and discuss almost all aspects of an organization's activities. Intellectual capital management has a strategic perspective and the function is to develop intellectual assets. Knowledge management is more focused on tactical and operational standpoints to manage the KM processes. The purpose of knowledge management is to control all the activities which are knowledge-related. Cabrita and Grilo (2012) state that the most important goal of intellectual capital is to enhance organizational performance by means of identifying, measuring and analyzing activities, which can improve intellectual capital value. The main objective of knowledge management is to make knowledge accessible for an organization, which means that all employees can make use of the available knowledge and share it with others. Overall, the authors see knowledge management as operational and intellectual capital as strategic. Daud and Yusoff (2011) and Zhou and Fink (2003) argue that knowledge management and intellectual capital complement each other and cannot be seen as two separate approaches. Intellectual capital is the key to innovation and a company's competitive advantage. In addition, the actions of knowledge management are based on gaining, developing and sustaining intellectual

capital. Thus, the processes of knowledge management can enhance the value of intellectual capital. Therefore, knowledge management and intellectual capital can support each other by linking the KM processes with the IC components. Marr, Gupta, Pike and Roos (2003) have almost the same reasoning, since they argue that successful intellectual capital management are thoroughly connected with the KM processes, which means that an effective implementation and usage of knowledge management can lead to the growth of intellectual capital. Thus, knowledge management can be the starting point for a successful leveraging of intellectual capital (Chan, Chu & Wu, 2012).

The two approaches discussed, knowledge management and intellectual capital, might have both another purpose in the case of knowledge mapping. Roos (1996) (cited by Heng, 2001) states that intellectual capital is more than just the knowledge, skills and experiences of employees. Other included aspects are the infrastructure, relationships (e.g. with customers), motivation of employees and other processes in order to use and develop the assets. Heng (2001) makes a distinction between knowledge and intellectual capital. Knowledge arises, since available data within an organization becomes information. In the end, this business-related and significant information becomes knowledge of an organization. The focus of intellectual capital is to create value for the company. It contains the critical knowledge, such as patents and trademarks (intellectual property) of an organization and additional knowledge assets, for instance the products, customers and processes. In general, knowledge management focuses on the creation, capturing, transformation and use of knowledge. According to Chan and Lee (2011) the ultimate goal is '*developing an intelligent organization by creating and maximizing intellectual capital*' (p. 99). Thus, the development of knowledge management can be the first step for intellectual capital management (Chan & Lee, 2011). However, an organization has to think about the approach of knowledge management, because knowledge can be mapped for the three categories of intellectual capital or only for employees. In this case knowledge is mapped for employees, which means that knowledge management is not always related to all aspects of intellectual capital.

Overall, both knowledge management and intellectual capital dispose of aspects, which are useful for this study. First of all, the perspectives of Alavi and Leidner (1999) and Anand and Singh (2011) regarding knowledge management are about the visualization of knowledge of employees and knowledge accessible for others. This is an important step in this research, because the focus is on the identification of available and required knowledge. It arises from knowledge mapping, which gives a better view with regard to available knowledge and where it resides. The knowledge management approach is partly consistent with the intellectual approach. This is mainly about the human capital aspect. Hereby knowledge and work-related experiences play an important role. Therefore, knowledge and experiences will be integrated, since the study is about mapping knowledge of employees. In general, the intellectual capital approach is partly used, in particular the human capital aspect.

To conclude, the review of both approaches has given more insight in which elements are important to identify. The knowledge management approach is used for the identification of knowledge, which is part of an extensive process. The elements knowledge and work experience that will be mapped, come from the definitions of knowledge and the human capital aspect, which belongs to the intellectual capital perspective. Thus, knowledge management is applied on the basis of the process and intellectual capital is included based on the human capital aspect.

3. Research methodology

In the methodology chapter the following aspects are shortly explained: the design-oriented research, steps of the regulative cycle, the interviews used to obtain data and the quality of the research (van Aken, Berends & van der Bij, 2007).

3.1 Design-oriented research

Design-oriented research is discussed, since this study is about the design of a tool to map knowledge. Therefore, it is important to understand what design-oriented research means to perform this type of research in the right way. According to Baumgart, Houri, Rückstieß, and Sehnke (2007) a design can be related to different things, such as an activity or an artifact. They see design as '*an activity, means ''to invent and bring into being" and creates something new that usually serves human purposes'*. Fallman (2007) defines a design as '*a process in which something is created – working out form of something new, consciously creating something which was not previously there'* (p. 195). The researcher needs a certain amount of participation from the people who are part of the design process. Another definition is from van Aken et al. (2007) who define a design in the following way *'a model of an entity to be realized, as an instruction for the next step in the creation process'* (p. 22). The entity consists of an object or a process. A model can be seen as an abstraction of the reality, which can contains many forms (e.g. drawings or texts). From my view the above definitions complement each other, because in this research a design can be interpreted as the creation of a new tool that focuses on human purposes, which can also be used as instruction for the next step of knowledge management. In other words, it is the intention to support managers with the aid of the tool by identifying knowledge of their departments. Furthermore, knowledge management in general can ensure that employees transfer and share knowledge with each other. Thus, the tool can also contribute to the next step in the knowledge management process.

Van Aken et al. (2007) define designing as *'the process of determining the required function of an object to be designed, combined with making a model of it'* (p. 23). Fallman (2007) argues that *'new knowledge, new descriptions of a state of affairs, is of a kind that cannot be attainable if design – bringing forth of an artifact such as a research prototype - is not a vital part of the research process'* (p. 197). These definitions suggested that the focus should be on the function of the design and the development of a model, which is also the case in this study. Moreover, a new tool or instrument can lead to unexpected positive results.

The definition used by Baumgart et al. (2007) to describe design-oriented research is that it '*produces new knowledge as its main objective. The creation of an artifact during this process plays an important role but is not the main goal'.* It seems contradictory, because one would expect that design-oriented research is about creating something new. The artifact itself could lead to new knowledge. Van Aken (2004) has another view of design-oriented research, since the goal is to develop a body of generic knowledge that can be used to solve business problems by designing a solution. To be more specific, design-oriented research can be related to business problems. The focus is on improvements and solutions of organizational problems. In addition, it might also include the change process which is necessary to realize the solution within an organization (van Aken et al., 2007). Overall, this study follows the reasoning of van Aken et al (2007), because the purpose is to design a tool to solve a business problem, which means that this study can be seen as a design-oriented research.

3.2 Regulative cycle

To carry out the research properly, we need to know the steps that are related to a design-oriented research. A design-oriented research for a business problem solving project follows the regulative cycle, which is represented in figure 4 (van Strien, 1997, cited by van Aken et al., 2007). The process of the regulative cycle consists of five basic steps: problem definition; analysis and diagnosis; plan of action; intervention; and evaluation (van Aken et al., 2007). In short, the regulative cycle begins with the investigation of a practical problem; then a design is developed; and lastly the most appropriate design is implemented and evaluated (Wieringa, 2009). The steps of the regulative cycle are applied to the current study as described below.

Problem definition

A research starts with the problem definition. It is an agreement between the principal of the project, the researcher and the supervisor (van Aken et al., 2007). Usually the principal gives the problem, but it is possible that this is not the real problem. Therefore, a problem analysis is needed to find out whether it is a perception problem, a target problem or eventually a part of an underlying problem. If this is excluded, there is a real problem.

In this study the principal of Eaton defines the changes within the workforce that lead to a need for a tool to map knowledge. These changes are: aging, outflow of elderly people and lack of technical personnel. The changes are also mentioned in the conducted interviews with other HR employees. From the interviews, the need for a tool to map knowledge of employees is also analyzed.

Analysis and diagnosis

The second step, analysis and diagnosis, is the more analytical part of the project. Both quantitative and qualitative methods can be applied with regard to the analysis and diagnosis phase. It leads to detailed knowledge of the context and nature of the problem. To check the validity of the business problem, factual information must be collected. In addition, a theoretical analysis is needed, whereby several perspectives are taken into account. Theory can be used as a guiding framework for the business problem. The advice of van Aken et al. (2007) is to include alternative explanations of different frameworks. The most useful explanation or a combination of both explanations should be selected.

First, factual data is collected related to the changes of Eaton to determine whether these changes are valid and lead to the problem of the organization. This involves data about aging, the inflow and outflow of employees. Second, a theoretical analysis is performed by conducting a literature review. According to Saunders, Lewis and Thornhill (2009) the main purpose of a literature review is '*to help you to develop a good understanding and insight into relevant previous research and the trends that have emerged*' (p. 61). Babbie (2007) emphasizes that it is important to organize the literature review in a way that the focus is on concepts that the researchers wants to study. This is also true for this research, because a literature review is conducted to get a better understanding of the main topics, which are knowledge management and intellectual capital. Moreover, there is literature collected about how to map knowledge. The concepts of knowledge management and intellectual capital are compared to determine the starting point of the design. Overall, the literature review is used to develop the new tool, which is part of the next step of the regulative cycle, namely the plan of action.

Plan of action

In the plan of action phase the solution of the problem will be designed and/or the related change plan. Knowledge of descriptive research can be applied to develop a solution. The central part of this step is a literature review. The ideal situation is that the literature review has yielded multiple solutions, which might be appropriate to solve the problem. From these solutions, the most suitable one will be selected. On the basis of the chosen solution concept a design can be developed to solve the problem, what has been explained in the previous part about analysis and diagnosis. Another source for possible solutions of the problem is the client organization (van Aken et al., 2007). A possibility is that the problem exists for a longer period. This can mean that different stakeholders have thought about solutions to solve the problem, which can be used in the design process of the tool. An important comment is that the researcher has to be careful by using the ideas of the client organization, since it can cause a 'tunnel-vision'. In this research, the literature, the review of existing tools and the requirements of Eaton are combined regarding the development process of the design.

The design starts with the specifications, which consists of four types (van Aken et al., 2007, p. 24):

- Functional requirements: performance demands on the object to be designed.
- User requirements: requirements drawn up from the viewpoint of the user.
- Boundary conditions: to be met unconditionally.
- Design restrictions: preferred solution space.

From my view, the boundary conditions and design restrictions are formulated. In addition, the functional and user requirements are based on conversations with the supervisor of Eaton, the HR employees, the managers of the front-end departments and the plant manager. This will be further explained in chapter 4.

Intervention

The intervention phase can also be seen as the implementation of the design. Work processes will be changed based on the developed design, which means that employees use the new design in practice. Thereafter, employees learn from the use of the new design and try to realize the pre-established performance.

In this research the tool is not implemented throughout the whole organization, because the aim is to test the tool. A small part of the front-end departments of Eaton have tested the tool. Besides, recommendations based on the implementation are prepared for Eaton. This can be used as guidance, when Eaton decides to implement the tool in other departments.

Evaluation

Evaluation is the final step in the regulative cycle. From an evaluation it should be clear whether a project to solve a business problem was successful or not. This might cause certain improvements of the design. The evaluation of the design gives an organization the opportunity to learn from problems that can be prevented in the future. In general, the evaluation is based on the perspective of the researcher and the perspective of the client organization. The researcher explains why the design or tool is a solution for the problem and what has to be done to realize the design. On the other hand, the organization makes the decision whether the tool is useful to implement.

The evaluation of the tool is performed together with the manager, supervisors and employees who are involved in the test phase, because the ultimate goal is that they will work with the tool in practice. In addition, a reflection is added to improve the design of the tool.

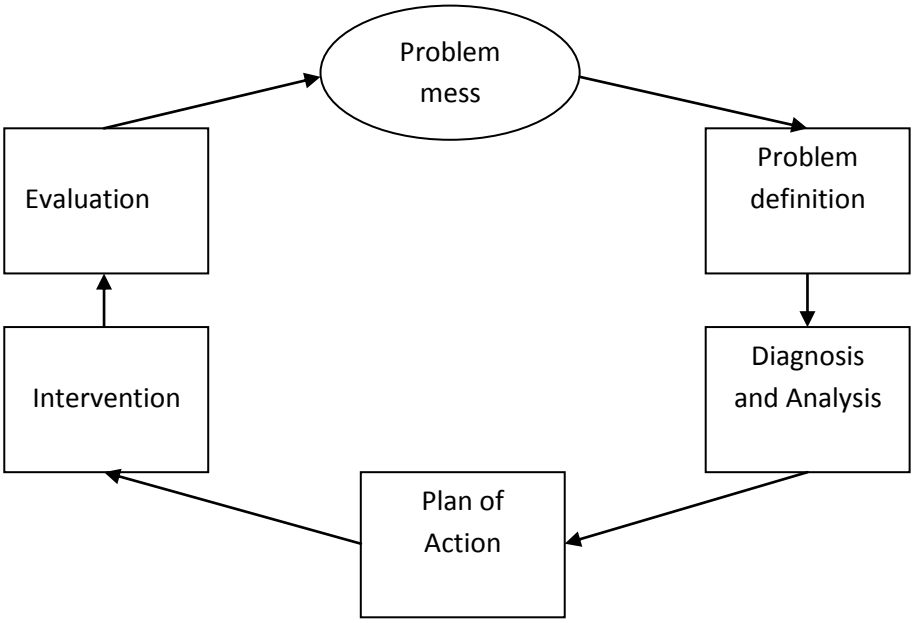


Figure 2: The regulative cycle

3.3 Interviews

According to van Aken et al. (2007) there can be made a distinction between qualitative and quantitative research methods. The authors mention that qualitative research methods are about the properties of objects, phenomena, situations, people, meanings and events. Quantitative research methods focus on numbers or amounts of these properties. Data collection methods for qualitative research are based on non-numerical data. In contrast, quantitative collection techniques use numerical data (Saunders et al., 2009). Punch (2005) uses a similar description, namely quantitative research is in the form of numbers and qualitative research is not in the form of numbers. This distinction is useful to determine which methods are appropriate for this study.

In summary, this research is qualitative, because of the design-oriented character of the study. In addition, the focus is on non-numerical data. There are several methods, which can be used in a qualitative study. These methods are also applicable for business problem-solving projects, the nature of the current study. An overview of methods associated with qualitative research is given by van Aken et al. (2007, p. 134). These methods are: interviews, focus groups, documentation, participative observation, verbal protocols and diaries. Bryman (2012) described the main methods used in qualitative research, which are participant observation; qualitative interviewing; focus groups; language-based approaches (e.g. conversation analysis); and document analysis.

There are two types of interviews applied to collect data. First of all, interviews are carried out to get more insight in the problem and need from Eaton to design a tool to map knowledge. The second type consists of interviews with managers and employees to obtain data and evaluate the results of the tool. These methods are further explained below.

Types of interviews

According to Babbie (2007) an interview is *'a data-collection encounter in which one person (an interviewer) asks questions of another (a respondent). Interviews may be conducted face-to-face or by telephone'* (p. 264). An addition of Saunders et al. (2009) is that interviews can also be carried out by using the internet (electronic interview). Interviews support the researcher to gain data, which is relevant to the research questions and purpose (Saunders, et al., 2009). The interviews are used to find out what the need of Eaton is in order to have a tool and to obtain data for the content of the tool, specifically the knowledge areas. In addition, the completed tools will be evaluated with the manager. We will also consider, together with the managers and the employees who are involved in the test phase, whether the tool needs to be improved.

There are different types of interviews vary from formalized and structured interviews to informal and unstructured conversations. It is important to define the different types, because it influences the structure of the interview. A common typology is the distinction between structured interviews, semi-structured interviews and unstructured or in-depth interviews (Corbin & Morse, 2003; Saunders et al., 2009). Corbin and Morse (2003) state that the main differences between the interview types are *'the degree to which participants have control over the process and content of the interview'* (p. 339). Kothari (2009) mentions that a structured interview *´involve the use of a set of predetermined questions and of highly standardised techniques of recording'* (p. 97). This means that the interviewer follows a predefined procedure consisting of predetermined questions. Usually researchers use a semi-structured interview to collect data, which is explained by van Aken et al. (2007) as *'using a list of specific questions, but leaving sufficient room for additional information'* (p. 135). A researcher has drawn a set of themes and questions. During the interview the researcher can decide to omit or add questions (Saunders et al., 2009). At last, there are unstructured interviews, which have an informal character. DiCicco-Bloom and Crabtree (2006) argue that *'no interview can truly be considered unstructured; however, some are relatively unstructured and are more or less equivalent to guided conversations'* (p. 315). The authors mention that this type of interview *'is conducted in conjunction with the collection of observational data'* (p. 315). Saunders et al. (2009) provide another argument regarding this reasoning. They state that the researcher make use of an unstructured interview with the aim *'to explore in depth a general area in which you are interested'* (p. 321). In contrast to structured and semi-structured interviews, unstructured interviews do not contain a list of predetermined questions. On the other hand, a researcher has to think about the aspects he wants to explore.

Interviews with employees of the HR department and the plant manager

The first step in the regulative cycle is the problem definition. As discussed earlier, it is the intention to discover the need of Eaton for a knowledge mapping tool. The question to map knowledge comes from the HR department. That is why there are interviews conducted with three employees of the HR department. Further, there has been an interview with the plant manager of Eaton, because it is assumed that he also knows something about the need for a tool. Semi-structured interviews are applied to get a better understanding of the specific need for a tool to map knowledge. The choice to use semi-structured interviews is that there is a list of questions, but also sufficient space for additional information. The procedure of the interview is as follows: introduction of the project and background; a short explanation of the goals of the interview; and why the interview is important for the project (van Aken et al., 2007). In addition, the interviewer should tell the respondent how the results will be used.

Conversation with managers and employees

The method used to gather data for the tool and evaluate the results with the managers of the front-end departments largely corresponds with unstructured interviews, because of the informal nature of that type of interviews. The unstructured interviews are part of the plan of action phase in the regulative cycle. It should be noted that this phase of the research is more dominated by conversations, which might be more or less the same as unstructured interview (DiCicco-Bloom & Crabtree, 2006). First of all, the managers of the front-end departments, the HR employees and the plant manager indicate what they expect from the tool, which leads to the requirements of the tool. Subsequently, conversations are held with the managers of the front-end departments to determine the crucial knowledge areas. Thereafter, the tool is completed by the employees, which is part of the test phase. This means that the tool itself is also a method to obtain data. The tool offers the possibility to map present and required knowledge of employees. This gives Eaton an overview of what knowledge exists within the organization. After completing the matrix there are conversations with the managers and employees to evaluate the content of the tool. This might lead to possible adjustments to improve the tool. In addition, the results of the completed matrices are evaluated with the managers.

Concluding, there are two methods used to collect data, namely semi-structured interviews and conversations. The interviews are used to discover the need from Eaton to design a tool for knowledge mapping. The conversations focus more on gathering information related to the content and outcomes of the tool. Finally, both the interviews and conversations provide information about the expectations and requirements of the tool.

3.4 Quality of the research

According to Morse, Barrett, Mayan, Olson and Spiers (2008) general criteria for qualitative research, which are reliability and validity, have to be taken into account during the research process. Verification plays an important role, which is *'the process of checking, confirming, making sure, and being certain'* (Morse et al., 2008, p.17). Verification supports the researcher to decide whether to continue or stop with the study or that certain changes are necessary. This affects the achievement of reliability and validity. The section continues with describing reliability, validity and methods used to improve the quality. Reliability and validity are important, since these aspects have influence on the results of a research. If the research meets both criteria it is more meaningful and there is less reason to doubt on the results (van Aken et al. 2007). Thus, researchers want to achieve a high reliability and validity within their own studies. Therefore, we examine which methods are used to increase the quality in this research.

Reliability

Saunders et al. (2009) define reliability as *'the extent to which your data collection techniques or analysis procedures will yield consistent findings'* (p. 156). To make it simple, if another person repeats the same research, using other research instruments, with different respondents or/and in another situation, it should give similar outcomes (van Aken et al., 2007). The key aspects in a design-oriented research are stability and the extent to which a research is imitable (van Burg, 2011). The results are reliable if the outcomes are stable by using the same methods and in similar circumstances. In addition, it might be difficult to fully replicate a research, so the other criterion for reliability is that a study is imitable. Thus, it must be possible for another researcher to perform the same research in a similar way.

Van Burg (2011) describes a number of guidelines, which are applicable in design-oriented research. These guidelines are linked to the quality criteria of design-oriented research. As mentioned above reliability contains two aspects, namely consistency and stability. Consistency can be improved by repeating the research in different cases. In contrast, the improvement of stability may depend on several factors. Stability can be determined by investigating a data source more than one time. It is also advisable to add a 'member check', because the interviewees can verify whether the results of their interview are correctly applied in the research. A crucial point to perform the research in a similar way is to write a research protocol. The protocol is a guideline that provides support in performing an existing research.

The stability is tried to accomplish by using different sources, recording the interviews and describing the research protocol throughout the study. The different sources are the semi-structured interviews conducted with different persons, namely the HR manager, two HR specialists and the plant manager. The main purpose of the interviews is to determine whether they have the same view of the changes within Eaton. They all indicate that aging, a low inflow and a natural outflow influence the knowledge level of Eaton. Furthermore, when employees leave the organization their knowledge is not mapped, which causes a loss of knowledge. Thus, if the interviewees give different answers the results are less stable. In other words, different sources are used to determine whether the answers are stable. The interviews are recorded and as well as literally elaborated, which ensures that results can be correctly applied in the research. In this study the results of the interviews are applied as literal as possible to increase the stability. Therefore, the 'member checks' are omitted, because the interviews are recorded. As mentioned, it is important for reliability that a research is imitable. Throughout this research the steps that have to be taken are clearly described, which makes it easier for other researchers to perform the current study in a similar way. The consistency has not been established, since the assignment is specific to Eaton making the results only applicable for this organization. However, a generic tool is developed which can also be used by other companies.

Validity

According to Saunders et al. (2009) validity is *'the extent to which data collection method or methods accurately measure what they were intended to measure'* (p. 603). This is equivalent to the definition of validity from Babbie (2007), namely *'validity is a term describing a measure that accurately reflects the concept it is intended to measure'* (p. 146). Van Burg (2011) distinguishes different types of validity (p. 9). The relevant types of validity for this research are briefly discussed, which also focus on the applicable guidelines and methods used to guarantee the types of validity.

Construct validity: the central question for construct validity is: do you measure what you want to measure? Therefore, important steps are to properly define the construct and the measurement instruments must have an overlap with the construct. According to van Aken et al. (2007) there are different ways to assess construct validity. Two of these procedures are: researchers can evaluate whether the elements of the measurement matches with the meaning of the concept; and experts might be included to assess the measurement method. To guarantee the construct validity both procedures are applied, since the purpose is to develop a valid tool. From my perspective the tool is evaluated to determine whether the elements fit with the concept (see section 5.3). Besides, one manager and two supervisors of the front-end departments are involved in the evaluation of the tool. The evaluation is applied to verify whether knowledge can be mapped by using the tool.

The evaluation can be seen as prevention to develop a tool that does not map knowledge (see section 5.3.1). Overall, the manager and supervisors indicate that the tool provides support to map knowledge of employees.

Convergent validity: different measurements of the same construct should give the same results. For example, conducting interviews with several persons should give some overlap with regard to the answers. For this reason interviews with four employees with a different background are conducted. The results of the interviews match with each other, which mean that convergence is reached. In addition, convergent validity in design-oriented research can be achieved by combining multiple data sources (van Burg, 2011). This concept is also known as triangulation; using several research methods with the result that the information of the sources can be combined (van Aken et al., 2007). For convergent validity this principle of triangulation is applied, because by using different methods all aspects of a construct can be covered. In this research multiple data sources are used (documentation, literature review, semi-structured interviews, conversations and the design itself) to combine the results. It creates a complete overview of the construct examined in the research.

Internal validity: the question is whether there is a 'real' relationship between the measured constructs or that other factors have influence on the corresponding relationship. This research is not about finding a relationship between constructs. Thus, internal validity cannot be determined with regard to conclusions about a causal relationship. However, internal validity can also be part of the diagnostic phase of a business problem and the related causes. Viewing the problem from multiple perspectives can ensure that the most important causes are found. A high internal validity is achieved when most of the actual causes of the problem are found (van Aken et al., 2007). Therefore, several perspectives can be included to discover the causes. Interviews and conversations are conducted with persons that have a different background to discover the main causes for the problem. The interviews revealed that aging, a low inflow and a potential outflow cause a loss of knowledge, because knowledge of employees is not mapped. Factual data are used to determine whether there is a 'real' problem.

External validity: to what extent are the results of a research within a specific environment generalizable to other groups or contexts? External validity is less important in design-oriented research. This type of validity can be increased by involving more objects in the research (van Aken et al., 2007). External validity is difficult to assess, because the focus of this study is specifically related to Eaton. In other words, the assignment to map knowledge came from Eaton. However, there is a generic tool developed, which might be applicable in other organizations. Therefore, the external validity can be improved by including more cases to test the tool.

Pragmatic validity: this type of validity is particularly important for design-oriented research. It is about the extent to which the research outcomes cause certain actions that lead to the desired effects on long term. Usefulness is a key criterion for pragmatic validity. To increase the pragmatic validity the researcher can make use of stories to describe how the design or tool can be applied. Throughout this study there is a description about how to apply the tool, which is also a kind of story. This provides a guideline for managers to implement the tool. Additionally, visualization of the design can increase the pragmatic validity. The usefulness is increased by means of visual representations of the tool. The visualization of the tool allows managers to quickly observe whether there is sufficient

knowledge within a function. Nevertheless the real test is to figure out if the design or tool works in practice. The ultimate purpose for pragmatic validity is to test the design or tool. In this research the tool is tested at the front-end department. The test is carried out to determine the usefulness of the tool. In others words, is the tool a solution for the problem? The test has shown that knowledge can be mapped by using the tool. The best validation of pragmatic validity is to implement the tool by someone who has not been involved in the research. However, the purpose of this research is to test the tool and not to implement it in the organization.

4. Design of the tool

In chapter two knowledge management and intellectual capital are discussed to determine which aspects of these approaches are suitable to map knowledge, taking the purpose of the study into account. The conclusion is that both approaches have aspects that are valuable for the new tool. This chapter is dominated by the development and the design of the tool. First of all, different existing tools to map knowledge are described. Thereafter, the specifications of the tool are described, followed by the details of the tool.

4.1 Existing methods and tools to map knowledge

In the literature, there is not much written about tools to map knowledge. To identify existing tools several search terms are used in Google Scholar, including: knowledge management, knowledge map, knowledge mapping, tools/instruments knowledge mapping, tools/methods to map knowledge, instruments knowledge identification and knowledge matrix. These terms are also translated in Dutch in order to search for existing tools in the Dutch literature. The search has yielded four existing methods/tools each with a different approach to map knowledge. The tools are: the knowledge matrix (van Daal et al., 1998), the knowledge audit (Liebowitz, Rubenstein-Montano, McCaw, Buchwalter & Browning, 2000), the knowledge map (Kim et al., 2003) and the Identick instrument (Blaauw, 2005). Reviewing the tools provides more insight with regard to how knowledge can be mapped. There might be aspects of the existing tools, which are applicable for the design of the tool in the current research.

4.1.1 Knowledge matrix

Van Daal et al. (1998) developed a tool, called the knowledge matrix, to determine the needed and present knowledge of an organization. The focus of the authors is on the first phase of the knowledge value chain (see appendix 3). The identification phase ensures that possible gaps, the negative difference between actual and desired knowledge level, can be detected. The matrix consists of two entries: knowledge areas and functional areas. Knowledge areas are related to the specific knowledge of an organization, which is crucial regarding a firm's mission, vision, objectives and strategy. The content of functional areas contains functions, tasks and activities which are covered by the responsibility of individuals or groups and can be defined at different levels of a company. Overall, the first step of the knowledge matrix is to establish the knowledge and functional areas. After completing this step, the current and desired knowledge levels must be identified. Therefore, van Daal et al. (1998) recommend a group session where employees give each other a certain grade or score per knowledge area to determine the current and desired knowledge levels for each employee. The authors use the scores from 1 to 10 (a score of 1 means a low knowledge level and a score of 10 means a high knowledge level). To discover knowledge gaps, a company has to think about the required knowledge per knowledge area, which can also be seen as the ambition of the organization. If there are negative gaps, it is useful to develop the level of knowledge of employees, which is part of the second phase of the knowledge value chain. Organizations have to keep in mind that the knowledge matrix is dynamic and knowledge areas may change over time. Below an example is given of a knowledge matrix carried out by van Daal et al. (1998) at Billet Mill a Dutch steelwork company located in IJmuiden.

Billet Mill	Functional Area (FA) Jones		Peters				Smith		Brown		Bush	
Knowledge Area:	Manager		Assistant manager		...		Team coach		Team coach		Head roller	
Metallurgy	3	6	3	3	...	...	3	6	5	7	5	7
Roller	4	5	8	8	...	...	3	6	5	7	6	8
Oven	5	5	3	3	...	...	3	3	1	6	2	4
Walsing	4	5	8	8	...	...	7	8	7	8	6	8
Walsing gear	7	3	5	6	...	...	7	8	5	7	6	8
...	...	...	...	...	...	...	...	...	...	...	...	...
Gauge	3	3	6	8			5	8	6	8	6	8
Cooling down material	3	5	3	8	...	...	4	6	5	8	7	4

Figure 3: Knowledge matrix: Billet Mill (van Daal et al., 1998, p. 261)

An advantage of the knowledge matrix is that it is a simple tool to identify available knowledge. In addition, present and required knowledge are represented in a clear way. A second positive point is that managers can quickly see whether there are negative gaps between the available and required knowledge. A disadvantage of the knowledge matrix might be that the current and desired levels of knowledge are determined for each colleague on the basis of group sessions. It is possible that people find it difficult to give an opinion about someone's knowledge level. Therefore, it might be an option to look at the strategy and based on that a company can determine the desired knowledge level. It is also possible to map crucial knowledge, by using the knowledge matrix.

4.1.2 Knowledge audit

Several authors (e.g. Liebowitz et al., 2000; Levy, Hadar, Greenspan & Hadar, 2009) mention that the knowledge audit is an essential part of knowledge management, which includes the business needs assessment, cultural assessment and the identification of required, present, missing and applied knowledge. Burnett et al. (2004) argue that a knowledge audit is *'able to describe what knowledge an organization has, who has it and how it flows (or does not) through the enterprise'* (p. 25). In general, the audit supports a company to identify the needs of the organization; what knowledge assets are available; the location of the assets; the knowledge gaps; and the flow of knowledge within the company (López-Nicolás & Meroño-Cerdán, 2010). The knowledge audit consists of physical and intellectual capital assets. De Lusignan, Wells, Shaw, Rowlands and Crilly (2005) describe that the knowledge audit includes two components, namely *'examination of what sources of data, information and knowledge are available and how they are used; and the perceptions of unmet needs'* (p. 69). Thus, an organization identifies the present and required knowledge and if the needs cannot be met by a company's intellectual capital, new knowledge must be developed. On the other hand, whether the needs can be fulfilled by one of the intellectual capital sources an organization can use technology to make the knowledge easier accessible for employees.

Liebowitz et al. (2000) describe three main steps to create a knowledge audit: the first step is to identify the knowledge that exists within the targeted area (the result is a knowledge map); the second step is to identify knowledge that is missing in the targeted area (by using a gap analysis); and the third step is to come up with recommendations and an advice from the knowledge audit to improve the knowledge management activities (p. 5). Important to recognize is that tacit knowledge is also part of the knowledge audit. The instrument includes two types of questionnaires. One

questionnaire is focused on the first step and the other on the second step of the knowledge audit (see appendix 4).

A benefit of the knowledge audit is that it clearly identifies what knowledge is needed to achieve organizational goals. It also compares current knowledge with missing knowledge, which provides recommendations to improve the knowledge management activities. A second advantage is that it gives employees the opportunity to find needed knowledge quickly. A limitation of this instrument is that it only performs the identification of knowledge and the business needs and cultural assessment are omitted. In this study it might not be a problem given the purpose of the research. The second disadvantage is that the knowledge audit is a time consuming instrument. The questionnaires have to be completed and the results are based on interviews with the managers. Lastly, a drawback for this research is that the audit focuses is on intellectual capital and less on the knowledge of employees.

4.1.3 Roadmap knowledge map

In section 2.2 the concept of a knowledge map is explained. The question that remains is: how can a knowledge map be developed to use it as a tool for knowledge management? Kim et al. (2003) give a detailed description of six procedures that have to be followed to develop a knowledge map, which represents the implicit and explicit knowledge that exist within an organization. The authors evolved a conceptual framework consisting of two elements: a diagram, which is a graphical representation of knowledge, and a specification, which is a more descriptive representation of knowledge (see figure 3). The steps to build a knowledge map are briefly discussed:

- Defining organizational knowledge: establishing the knowledge ontology and developing the taxonomy. Kim et al. (2003) mention that ontology is *'a formal specification of the vocabulary to be used in specifying knowledge'* (p. 38). The goal is to represent knowledge types that belong to a specific situation or process. The taxonomy is about the scope of the knowledge map, for example will it be developed for the whole company or for only one department. In addition, it is about how specific the information should be.
- Process map analysis: producing a process map based on task flows. This means that a process consists of several tasks or actions. To manage the knowledge within these processes, it becomes easier to find solutions for problems.
- Knowledge extraction: extracting knowledge based on each process defined in a process map. Different techniques can be used to extract knowledge, such as interviews, document analysis, system analysis or workshops.
- Knowledge profiling: from the extracted knowledge a knowledge profile will be created. Some attributes of the knowledge profile are: keywords, title, description and location.
- Knowledge linking: the knowledge link is part of the knowledge map and is represented as an arrow. It is useful, since the identification of knowledge flows in an organization is easier with knowledge linking.
- Knowledge map validation: the last step is to talk with experts, managers and the producer of the knowledge map. The benefit might be that the validity is higher when there are other people involved by evaluating the knowledge map.

Creating knowledge maps provides the organization an overview of the present knowledge, which can be seen as a benefit. The knowledge can be shared among all the employees within a company. This means that knowledge assets are visible for all employees and it is easier to find the needed information. One of the disadvantages of this approach is that it was tested at a manufacturing company and it gives no certainty that it can also be applied to other companies. In addition, it is a comprehensive process and it may take a lot of time to perform all the steps. Furthermore, the roadmap concentrates on intellectual capital. Another disadvantage might be that employees do not understand the flow of knowledge within the organization, which makes it difficult for them to find the right information.

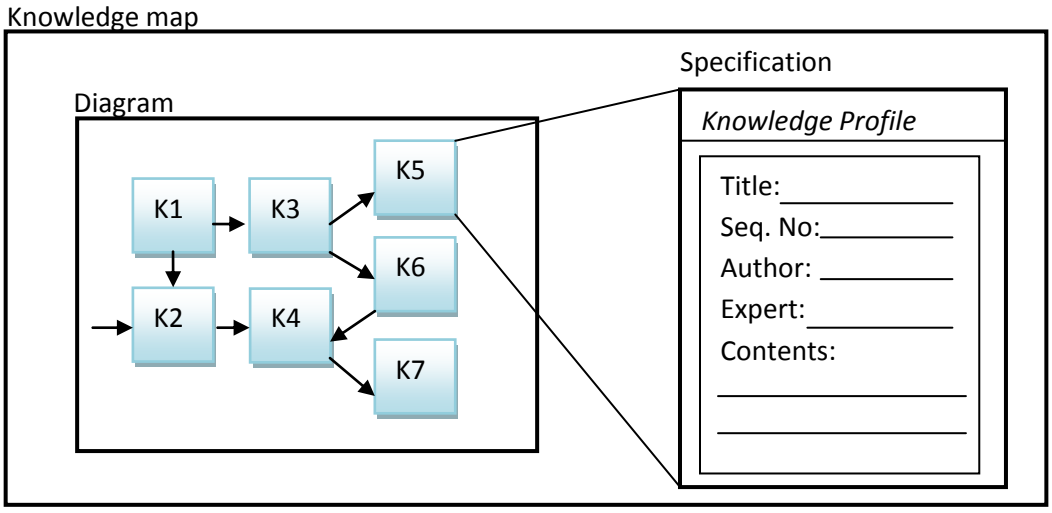


Figure 4: A conceptual model of a knowledge map (Kim et al. 2003, p. 36)

4.1.4 Identick

Blaauw (2005) developed an instrument to identify and map crucial knowledge of organizations, which is called 'Identick'. The instrument comprises eight steps that have to be taken to create a knowledge map. In this part the steps are briefly discussed (for a more detailed overview of the steps and subcategories, see appendix 5). It starts with the formulation of the functionality of the knowledge map to gain insight in the knowledge building of an organization. Thereafter, a choice must be made of the organizational components that will be mapped, which are related to knowledge domains. The author makes the distinction between the organizational and the individual level. The components of the organizational level are the strategic position and the primary process. Elements of the individual level are the knowledge carriers, their activities and communication networks. Finally, the structure of the knowledge map is designed and the level of detail can be determined. These three steps belong to the first phase of the 'Identick' instrument. The next phase consists of two steps: choosing a descriptive method to capture the research data and collecting of information or data. After the data collection an organization can start with the preparation of the knowledge map, which is the last phase of the instrument. First, the data will be analyzed and classified. Subsequently, the data of the research are linked to each other based on their classification and interpret by using analysis techniques. The results are the starting point of identifying the crucial domains within a company. The last step in the process of the tool is giving feedback to the knowledge carriers of the organization. The purpose of the feedback is to minimize the chance of inaccuracies.

A positive point of the tool is that it supports a company by creating a knowledge map. The outcome is that available and required knowledge become visible and crucial knowledge can be identified. A critical side of 'Identick' is the complexity of the process and it may take much time before the knowledge map is developed. In addition, it is only tested by two cases, which might not be representative for other firms.

4.1.5 Conclusion

In the previous sections different tools to map knowledge are described. The advantages and disadvantages of the tools are also briefly discussed, which is summarized in table 2. Below there is a short conclusion about the aspects of existing tools that are useful for this study.

The starting point of the new tool is mainly based on a combination of knowledge matrix (van Daal et al., 1998) and the knowledge audit (Liebowitz et al., 2000). The knowledge matrix is included, because it is a simple tool to map present and required knowledge. In addition, crucial knowledge areas will be determined, which is also part of the knowledge matrix. The first step of the knowledge audit is the identification of knowledge within a target area. This is also applicable for the new tool, because knowledge of employees is identified. The approach and the content of the tool are partly different in relation to the existing methods. Firstly, the employees do not determine the knowledge areas, but the managers perform this task. The assumption is that managers have a good overview of the crucial knowledge areas. The required knowledge can be determined based on percentages, so it is not based on the opinion of employees. And the content is not only about the knowledge, but also the work experiences of employees are taken into account. A further elaboration can be found in the next sections.

Existing tools	Advantages	Disadvantages
Knowledge matrix	Simple tool to map knowledge; it offers the opportunity to quickly identify knowledge gaps	Employees can have problems by determining current and desired knowledge levels of others
Knowledge audit	Identifies available, required and missing knowledge; it indicates the location where knowledge resides	Time consuming instrument; the focus is primarily on intellectual capital
Roadmap knowledge map	Gives an overview of available knowledge; makes knowledge assets visible	Extensive process; the focus is on intellectual assets; the possibility exists that employees do not understand knowledge flows
Identick	Identifies crucial knowledge within the organization	Complex process; generalizability might be low, because it is tested at two cases

Table 2: Overview advantages and disadvantages of the existing tools

4.2 Specifications of the tool

A design starts with the establishment of specifications. This research focuses on the design of a tool to map knowledge of employees from Eaton. Therefore, we have to determine which specifications are important for the tool. The specifications are related to boundary conditions; design restrictions; functional requirements; and user requirements (van Aken et al. 2007).

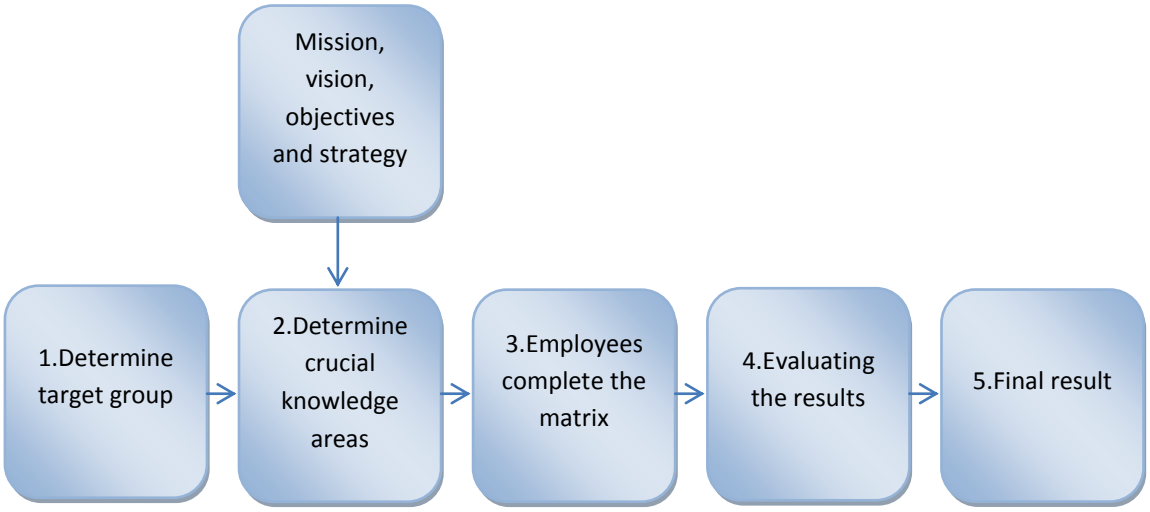
There are a number of specifications formulated to develop the tool, including boundary conditions and design restrictions. As mentioned above, the knowledge matrix (van Daal et al., 1998) and the knowledge audit (Liebowitz et al., 2000) contribute to the design of the tool. These tools are partly used to define the specifications. The initial concept consists of a matrix wherein crucial knowledge areas are central. Blaauw (2005) defines knowledge areas as *'islands of knowledge'* within the organization, which will be identified. An important specification of this tool is to define not too much knowledge areas, otherwise it will be too complex (Nonnekes, 2005). On the other hand, the risk of determining a few knowledge areas is that the tool is not complete enough. It is difficult to set a limit for the number of knowledge areas. There is some literature based on competence management, which examines the number of core competences. This can be applied to this research, because knowledge is part of competences. According to Perunović, Mefford and Christoffersen (2012) an organization can have an unlimited amount of competences, but it is common to define the most significant competences. A guideline for the number of significant competences used by several organizations is 10 to 12 (van Beirendonck, 2004). Eaton can use these numbers as guideline for defining the knowledge areas, because the focus is on crucial knowledge. In other words, it is about the most significant knowledge, which can be divided into knowledge areas. It has to be mentioned that the knowledge areas are different for each function. The second specification is related to what is going to be mapped. The tool represents present knowledge of employees. From the knowledge levels it can be determined whether the required knowledge is available, which is explained later on in this chapter. Hereby, different colors are used to identify knowledge gaps quickly. A third specification is that the matrix not only includes the knowledge level of employees, but also the transfer of knowledge (easy or difficult), the degree of experiences (beginner or expert) and the transfer of experiences (easy or difficult). This means that knowledge and experiences are part of the tool. The transfer of knowledge can be important, because if Eaton knows that an employee with crucial knowledge leaves the organization it is useful to be acquainted with the difficulty to transfer knowledge. Eaton can take steps based on how easy or difficult it is to transfer the crucial knowledge. The same also applies to the transfer of experiences. The degree of experience is taken into account to determine whether an employee has much experience (which is important for the organization). The most important employees have both crucial knowledge and experiences. The fourth specification is related to changes in the environment. Crucial knowledge areas are determined based on the mission, vision, objectives and strategy of Eaton. It is possible that changes in the environment ensure adjustments in the strategy. The tool is developed in such a way that employees or managers are able to make adjustments. The last specification is that the tool can be used by every employee within the organization. This means that the design of the tool is understandable for all the employees. Therefore, a kind of manual will be added that provides employees a 'grip' to complete the matrix.

On the basis of the conversations and interviews with the supervisor from Eaton (HR specialist), the HR employees, one manager and two supervisors of the front-end departments, and the plant manager the requirements are outlined. Several stakeholders are included to define the requirements, because the ultimate purpose is that managers within the organization can make use of the tool. The most important requirement of the managers and HR employees is that it should be a simple and clear tool. This means that only the (crucial) knowledge and experiences of employees are described, so not too much aspects should be included. The managers also mention that the tool must clearly indicate where the risks are located. In addition, it is not a comprehensive tool including

many employees that only have basic knowledge, since it has less influence on the distinctiveness and competitive advantage of Eaton than crucial knowledge. To be more specific, teams or departments that are less important for the distinctiveness of Eaton can be excluded. A simple tool also means that the organization does not need to undertake many steps to map knowledge; there are no difficult techniques and analyses used. Furthermore the tool will represent both present and required knowledge. Overall, the available knowledge must be clearly represented in the tool. The preceding is more about the functional requirements. There are also requirements based on the perspective of the users, specifically user requirements (van Aken et al. 2007). The point is that the tool can be easily used by different employees within the organization, so that information can be found quickly. Further to this criterion, managers at a decentralized level must be able to use the tool. Finally, it should be a tool that is maintenance-friendly. In other words, it will not take too much time to keep the knowledge up to date.

4.3 Details of the tool

This section includes the first version of the tool with the associated components. It consists of a knowledge-experience matrix, representing the presence of knowledge and experiences of employees. The steps that have to be taken are shown below and are shortly summarized. Thereafter, the steps are described in more detail.



First of all, an organization determines the target group from which the knowledge is mapped. This ensures that a company can focus on a specific group, since it might take much time to map knowledge of the whole organization. Subsequently, the crucial knowledge areas are determined, where the mission, vision, objectives and strategy are taken into account. In other words, which areas are important to achieve the pre-established mission, vision, objectives and strategy? After the knowledge areas are defined, the employees complete the matrix. From this, it can be concluded whether knowledge and experiences are available. Furthermore, the gaps can be determined, which means that there is a negative difference between present and required knowledge. Lastly, the results and the content are evaluated with the managers. In addition, employees are asked to evaluate the content of the tool. The evaluation is performed to make the tool more valid. On the basis of the evaluation the final result is drawn. In the next sections the aspects of the initial version of the tool are explained in more detail.

4.3.1 Target group

It all starts with determining the target group within the organization. From this group the explicit and implicit knowledge can be mapped. The first step is also part of the knowledge audit from Liebowitz et al. (2000). We look at what knowledge is available in a particular group to extract the employees which have much knowledge and experiences. Focusing on a specific group might be better to find out whether the elements of the tool are useful or that adjustments are needed. In addition, the focus is on areas where crucial knowledge plays an important role. This type of knowledge distinguishes the proceedings of Eaton from other companies, which also affects their competitive advantage. In this study there are three groups selected from the front-end departments. The groups are established through a conversation with the supervisor of Eaton. The front-end departments are important for Eaton, since they make the quotations and transform these quotations into orders. Moreover, the design and implementation of products by using computer software are important to meet customers' needs. Ultimately, an important task of front-end is to sell the products to earn money, which is a crucial part for the whole organization.

4.3.2 Crucial knowledge areas

After determining the target group managers have to think about the knowledge areas, which are crucial for the organization. This is partly included in the knowledge matrix (van Daal, et al., 1998) and in the instrument 'Identick' developed by Blaauw (2005). Van Daal et al. (1998) define knowledge areas by means of an organization's mission, vision, objectives and strategy. In addition, one of the steps of the 'Identick' instrument is to identify crucial knowledge areas (Blaauw, 2005). In my opinion the knowledge matrix (van Daal et al. 1998) gives a clear description to define knowledge areas instead of 'Identick' which is more complex (see section 4.1.4 or appendix 5 for a more extensive description of these instruments).

The assumption is that managers have an overview of the knowledge areas that are important in their working field. As mentioned before, the managers have to keep the mission, vision, objectives and strategy in mind. From the perspective of Eaton, it is the intention to follow the strategy and achieve the related objectives. The knowledge areas contain knowledge related to the strategy and objectives of Eaton. Moreover, the managers determine the crucial knowledge areas. In this case the knowledge areas are established by performing conversations with the managers. It should be mentioned that these knowledge areas varies by function. Specifically, not every function needs the same knowledge, which means that the knowledge areas are also different. The functions which are central in the test phase are described in chapter 5.

4.3.3 Knowledge-experience matrix

There can be set limits with regard to the number of persons that have to fill in the matrix. In this case employees of different functions of the front-end departments are selected to test the tool. The purpose the knowledge-experience matrix is to extract employees with much knowledge and experience. It is plausible that the knowledge-experience matrix illustrate a distinction between employees who have no knowledge and experience of a certain area and employees that are experts of the same area.

The content of the tool consists of the crucial knowledge areas, knowledge levels, the transfer of knowledge, the degree of experience and the transfer of experiences. The previous is represented in an individual matrix. Ultimately, there can be made an overview of the knowledge and experiences levels by representing the matrix by function. In other words, the function matrix contains the results

of employees within a certain function. This actually means that there are two matrices: an individual matrix and a matrix for the function.

The difficulty to transfer knowledge and experiences and the degree of experiences are part of the tool. It takes time to capture knowledge, when an employee with much knowledge and experiences leaves the organization. If knowledge and experiences are well controlled by an employee, it can be used to develop yourself or others (e.g. to perform tasks more effectively). It also provides an indication about the time needed to transfer knowledge or experiences. In sequence, the content of the tool with the related elements are described below.

Knowledge areas

The manager and supervisors, part of the test phase, determine the crucial knowledge areas of the front-end departments of Eaton. In this phase it is insufficient to define the knowledge areas, without knowing something about the content. This means that managers have to think about what employees should know with regard to a certain knowledge area. As a result, the general knowledge areas turn into a specific description of what an employee should know.

Knowledge levels

The knowledge levels are divided into five types, namely no knowledge, basic knowledge, applied knowledge, specialized knowledge and expert knowledge. This scale partially corresponds with the scale of the skill matrix used by Eaton, which consists of basic skills, understand skills, skilled and excellent skilled (for a short description of the skill matrix, see section 5.3.1). There is a brief explanation of the types of answer possibilities.

No knowledge: there is no or too little knowledge available regarding the knowledge area.
Basic knowledge: an employee has some knowledge about the knowledge area; development is necessary.
Applied knowledge: an employee shows that he/she has basic knowledge about a certain knowledge area; you can use the basic knowledge in different situations.
Specialized knowledge: an employee has sufficient knowledge about the knowledge area; you are able to improve current situations and problems can be solved.
Expert knowledge: the employee has a lot of knowledge and can support others; someone shows more than expected.

The knowledge levels are known, but we have to determine when knowledge is present or not, otherwise present and required knowledge cannot be compared. The boundaries of the different knowledge levels are indicated with percentages, which are given below.

No knowledge: 0 - < 20%
Basic knowledge: 20 - < 40%
Applied knowledge: 40 - < 60%
Specialized knowledge: 60 - < 80%
Expert knowledge: 80 - 100%

The choice to use these percentages is related to one of the requirement, mentioned by the HR employees, one of the managers of the front-end departments and the plant manager, namely to develop a simple tool which is easy to use. With the aid of these percentages it is easy to assess

whether knowledge is available or not. The limit is placed at 60%, since the assumption is that above this level employees have sufficient knowledge of a certain crucial knowledge area. The employees with a score of less than 60% have not the required knowledge. Overall, this can cause differences in terms of present and required knowledge of employees. Thus, a combination of the knowledge levels and the percentages provides Eaton more clarity with regard to the required knowledge.

Transfer of knowledge

For Eaton it is important to keep the crucial knowledge of employees 'in house'. It is advisable to transmit the crucial knowledge of an employee to a colleague. The transfer of knowledge may depend on the type of knowledge. Explicit knowledge is easy to transfer to other peoples, because it can be expressed in a certain language. It is more difficult to transfer implicit knowledge, since this knowledge is in the minds of people.

Degree of experience

The degree of experience is an addition to the knowledge level of employees. Experiences can be seen as implicit knowledge and van Daal et al. (1998) define experience as *'knowledge obtained through discovery or observation'* (p. 256). The issue is whether an employee has a high degree of experiences about a crucial knowledge area or not. In this case the knowledge level and the degree of experiences are compared. If both are high, employees can be essential for Eaton, because they have the knowledge and experiences about the crucial knowledge areas. The degree of experience is measured by using five answer possibilities (Liefhebber, Radema & van Arensbergen, 2010) and with the same boundaries as the knowledge levels:

Beginner: 0 - < 20%
Advanced beginner: 20 - < 40%
Competent: 40 - < 60%
Proficient: 60 - < 80%
Expert: 80 - 100%

Transfer of experiences

The transfer of experiences can be a key factor in the matrix as well as the transfer of knowledge. Employees with a high degree of experiences are crucial for Eaton, because they can support the organization in order to distinguish themselves from competitors. The distinction in the transfer of experiences is based on generic and specific experiences. The assumption is that generic experiences which many employees have are easier to transfer than specific experiences which limited employees have.

Summary

In the matrix both knowledge and experiences are mapped. By using knowledge levels and degree of experiences the available knowledge can be determined. In this case an employee with a score above 60% for both knowledge and experience regarding a certain knowledge area is crucial for Eaton. To make it more specific, this employee has specific or expert knowledge and is a proficient practitioner or expert concerning the experience. If this employee stops working for Eaton it is useful to know whether the knowledge and experiences are difficult to transfer or not. This provides the possibility for Eaton to keep knowledge and experiences inside the organization. But the opposite can also

occur, namely an employee has a score below 60% for knowledge and experience. Here, the organization can conclude that knowledge and experience are not available.

But what if employees have specialized or expert knowledge, and are beginner, advanced beginner or competent with regard to the experience? It is clear that these employees are important for the organization, but certain development is needed to increase the experience level. To bring these employees on a higher level might take less time than someone who scores for both knowledge and experience less than 60%.

4.3.4 Evaluation

The completed matrices will be discussed with the managers, because it might be possible that employees think that they have the knowledge, while a manager has another feeling or view regarding the employees' knowledge level. This also applies to the degree of experiences. Thus, together with the manager it will be examined whether the completed matrices correspond to what they have in mind. There can be made adjustments, after the matrix is completed by the employees. In addition, employees will be involved in the evaluation process regarding the content of the tool. Employees might have suggestions to improve the tool, for example by adding other knowledge areas which are important from their perspective.

4.3.5 Final result

The purpose of the study is to develop a tool which represents available and required knowledge. Crucial knowledge areas are determined, which include the knowledge that is needed to follow the strategy and objectives. An employee must have sufficient knowledge about the knowledge areas. The final result contains two matrices, namely an individual matrix and a matrix of the employees within particular function. Both matrices include the present knowledge levels and the degree of experiences. These levels can be compared with the established percentages to conclude whether the required knowledge and experience are available. The function matrix only takes the knowledge and experience levels into account, because a manager can quickly identify the available levels. The identification of available knowledge is the first step in knowledge management. If the organization continues with knowledge transfer the individual matrix can be used. Specifically, the transfer focuses on crucial employees who have sufficient knowledge and experiences. This means that the transfer does not apply to every employee, i.e. not all knowledge needs to be transferred. The design of the matrices is given below (see figure 5 and 6).

Knowledge area	Knowledge level					Transfer of knowledge			Degree of work experiences					Transfer of experience		
Knowledge area 1																
Knowledge area 2																
Knowledge area 3																
Knowledge area 4																
Knowledge area 5																
Knowledge area 6																
Knowledge area 7																
Knowledge area 8																

Figure 5: Individual knowledge-experience matrix

Function:	Knowledge level	Degree of experiences	Name 1		Name 2		Name 3		Name 4		Name 5		Name 6	
Knowledge area 1														
Knowledge area 2														
Knowledge area 3														
Knowledge area 4														
Knowledge area 5														
Knowledge area 6														
Knowledge area 7														
Knowledge area 8														

Figure 6: Function knowledge-experience matrix

5. Test phase and evaluation

In this chapter an explanation is given about the procedure before the tool is tested. It also examines the results of the test phase, which are discussed with the manager and supervisors. There is an evaluation with the manager, supervisors and employees in order to determine whether adjustments of the tool are necessary.

5.1 Procedure

Knowledge can be mapped for different levels, for instance individual level, team level or organizational level. The aim of this study is to test the tool and it is not the intention to fully implement the tool. Therefore, three functions of the front-end departments are included to test the tool.

To determine which managers and employees were able to participate in the test phase an email was sent to three of the managers of the front-end departments to plan an introductory meeting. The purpose of the meeting was to ask the managers whether they could assist in determining the crucial knowledge areas. Two of the managers were not able to determine the knowledge areas, because of a lack of time. The other manager was willing to provide support with regard to the research. In the first conversation we decided that the crucial knowledge areas of three functions would be determined. The following functions are included: application engineer, order manager and order processing manager. The knowledge areas of the three functions were elaborated together with the manager, the supervisor of the application engineers and the supervisor of the order (processing) managers. To include the supervisors a complete overview of the knowledge areas can be obtained. The knowledge areas of these functions are divided into specific knowledge that is actually needed. In other words, it is about the content of a certain knowledge area. The knowledge areas for the three functions are shown in appendix 7. Before the employees complete the matrix, the supervisors gave a short introduction. The purpose of the introduction was to explain the content of the matrix and the added value of the new tool. Additionally, there was an introduction added to the matrix (see appendix 8), which could be useful to complete the matrix. Twelve employees completed the matrix, consisting of six application engineers, three order managers and three order processing managers.

5.2 Results

In this section the most remarkable results are described for each function. We have to keep in mind that the results relate to the employees who completed the matrix. Based on the results a conclusion can be given about employees that have sufficient knowledge and experiences. Therefore, the present knowledge is compared with the required knowledge by looking at the knowledge levels. In this research, the required knowledge and experiences are equal to the knowledge levels ‘specialized’ or ‘expert’ and the experience levels ‘proficient’ or ‘expert’. Specifically, all employees must have more than 60% knowledge and experiences about all the knowledge areas.

Colors are added to the matrices in order to represent the results more clearly. For the knowledge levels and the degree of experiences the same colors are used. The colors for the transfer of knowledge and experiences are also the same (see the description below).

No knowledge and beginner: red
Basic knowledge and advanced beginner: orange
Understand knowledge and competent: yellow
Specialized knowledge and proficient: green
Expert knowledge and expert: blue

Easy to transfer knowledge and experience: green
Average to transfer knowledge and experience: yellow
Difficult to transfer knowledge and experience: red

The following part describes the results of the application engineers, the order managers and the order processing managers. For the description of the results the percentages shown in section 4.3.3 are used. For a complete overview of the results, both the individual and function matrices, see appendix 9 and 10. In advance, it should be mentioned that the knowledge levels and degree of experiences in the function matrices are linked to numbers (1 is the lowest level and 5 the highest level).Thus, the organization can immediately see whether there is sufficient knowledge and experience within a function (see appendix 10).

Application Engineer

The application engineers, part of the test phase, have less than 60% knowledge and experiences regarding the knowledge area mechanical engineering and materials. In advance, this knowledge area is a risk, because of a lack of knowledge and experience. Knowledge development can play an important role in order to ensure that these levels increase. There is only one application engineer who has more than 60% knowledge and experiences about all the other knowledge areas, which are electrical engineering; product portfolio; Sales Country Organization; BID manager; PC and software; norms, standards, procedures and guidelines; and Dutch, English and German. Therefore, this person can be of crucial importance for Eaton. In addition, the knowledge area PC and software has just one employee with specialized knowledge and experiences. This can be a risk area, especially if this person leaves Eaton. For the other knowledge areas there are at least two persons with specialized/expert knowledge, which means less risk. On the other hand, the experience levels are not sufficient in most cases, thus improvement is recommended. There is an employee who has only (basic) applied knowledge and is advanced beginner or competent with regard to six of the eight knowledge areas, which means that the levels are less than 60%. This employee needs the most development to increase the knowledge and experience levels. The employees have reported that the transfer of knowledge and experiences is generally easy or average. Two persons suggest that the transfer for mechanical engineering and materials is difficult. One employee indicates that the transfer for norms, standards, procedures and guidelines is difficult, while the others do not share this. It might be that these employees have mainly implicit knowledge and/or specific experiences about the mentioned knowledge areas. Overall, it seems that knowledge and experiences of application engineers are transferable.

Order Manager

All the three order managers have not enough knowledge and experience about the knowledge area mechanical engineering and materials. If Eaton needs knowledge on mechanical engineering, they might have a problem, because of the lack of knowledge among order managers. There is one order manager who has more than 60% knowledge and experience with regard to the knowledge areas

electrical engineering; organization and business processes; project management; PC and software; IEC norms and standards; incoterms and payment conditions; cost control orders; and Dutch, English and German. This employee is crucial for Eaton, because of his knowledge and experience levels. Another order manager has sufficient knowledge about electrical engineering; organization and business processes; project management; and PC and software. On the other hand, the level of experience of this employee needs some attention for project management and PC and software. For the remaining knowledge areas IEC norms and standards; incoterms and payment conditions; cost control orders; and Dutch, English and German; this order manager has too little knowledge and experience. The last order manager has not enough knowledge and experiences about all the knowledge areas. There is a risk that if the specialist/expert leaves, the other order managers cannot perform his tasks, because they have insufficient knowledge. The employee with more than 60% knowledge and experience has indicated that the transfer is not easy. All the more reason to suppose that this employee has implicit knowledge and specific experiences. This employee can be very important for Eaton. In general, the two order managers, which have not an adequate amount of knowledge and experiences, indicate that the transfer is not difficult. This can mean that it take less time to transfer the knowledge and experiences of these order managers, because it is not about implicit knowledge or specific experiences.

Order Processing Manager

The order processing managers have sufficient knowledge with regard to organization and business processes; PC and software; and the languages Dutch, English and German. The experience level for these areas can still be improved by two of the three order processing managers. The remaining knowledge areas electrical engineering; mechanical engineering and materials; IEC norms and standards; and incoterms and payment conditions do not contain the recommended knowledge and experience level. This means that there is already a risk for the function order processing manager. In general, the order processing managers need to increase their knowledge and experience level. At the moment, there is no employee which can be referred as crucial, because they do not have knowledge and experiences about all seven knowledge areas. There are very different answers for the transfer of knowledge and experiences. One of the order processing managers answers particularly with average or difficult, the second one mainly with easy and average and the last one uses all the three answer possibilities. Beforehand, the expectation was that the transfer is more difficult if an employee has a high level of knowledge and experience. The results of the order processing managers suggest that this is not always the case. An example, an order processing manager answered with applied knowledge on electrical engineering (less than 60%) and with difficult regarding the transfer of knowledge. It can be that the knowledge of this person is in particular implicit. Here, it can be assumed that knowledge level is independent of the difficulty to transfer knowledge. But the ultimate purpose is to transfer knowledge and experiences of crucial employees.

5.3 Evaluation

An evaluation is given based on the solution of the business problem and the results of the test phase. First of all, I give an evaluation from my own perspective to define whether the tool is a solution for the problem. In other words, has the result brought what you wanted to achieve at the begin of the research. Afterwards, the results of the tool are evaluated with the supervisors and employees are asked to evaluate the content of the tool.

The general purpose of the study is to develop a tool to map knowledge of the employees from Eaton. This purpose is achieved, because the knowledge is mapped by means of knowledge and experience levels of employees about knowledge areas. Thus, Eaton knows which employees are important for the organization looking at the knowledge and experience levels. Crucial knowledge can be transferred to employees that have less knowledge. This allows Eaton to prevent a loss of knowledge and keep knowledge inside the company.

In the tool the degree of experiences and the transfer of knowledge and experiences are also included. There is not much literature and information about mapping experiences, but that does not mean that it is less important than knowledge. The most crucial employees of the organization can be identified by taking knowledge and experiences into account. The difficulty to transfer knowledge and experiences provides guidance for Eaton when employees leave. As organization you want to retain crucial knowledge. Besides, knowledge and experience can be transferred to other employees to increase their level. It is difficult to state that the tool is the right solution for Eaton. As mentioned earlier, the tool offers Eaton the possibility to get a better understanding of the knowledge and experiences of their employees. The interviewees also said that the tool can be a first step in the 'right direction' to map knowledge. Overall, the inventory of available and required knowledge is the first step in knowledge management. The ultimate intention is to transfer crucial knowledge and share knowledge and experiences with each other. Therefore, Eaton should continue with the next steps of knowledge management.

5.3.1 Evaluation manager, supervisors and employees

Conversations with the manager and supervisors are conducted to evaluate the results of the tool. Furthermore, employees are asked to evaluate the content of the tool. The manager of the front-end department has the idea that the tool can add value to the company. It gives an indication about the knowledge and experience levels of employees. The results of the tool can contribute to the development of employees, which have a low score. The manager also mentioned that it is helpful to think about the specific knowledge, which is needed at the front-end departments. The supervisor of the application engineers is also positive with regard to the tool. However, he suggested that the tool can create more value, when it will be combined with the skill matrix. The skill matrix of the front-end department distinguishes technical skills regarding products; commercial skills; Eaton Business Systems and Tools; and other skills. The skill matrix represents the level of an employee with regard to the different skills. The mentioned reason to combine the tool with the skill matrix is that the skill matrix describes products and systems separately. In the knowledge-experience matrix the products or systems are included in one knowledge areas and are not described separately. Furthermore, the organization has to continue with the retention of knowledge. In his opinion, it is valuable to develop one central system where employees can find information. The supervisor of the order managers and order processing managers considers the tool as very interesting. It gives a representation of the available knowledge and experiences within a function or department, which can be used to develop employees.

The supervisor of the application engineers had a few adjustments with regard to the knowledge and experience levels of three employees. A minor change for one of the application engineers is that the experience about electrical engineering is one level higher. The second application engineer scores too low on sales country organizations; BID manager; PC and software; and Dutch, English and German. Both knowledge and experience are one level higher in the view of the supervisor. The

manager found that one of the application engineers scores one or two levels lower than the supervisor expected. The knowledge areas in question are: electrical engineering; product portfolio; sales country organization; BID manager; PC and software; and norms, standards, procedures and guidelines. The supervisor also noted that there are four employees who marked average on knowledge transfer, while he thinks that it is about explicit knowledge, which is easily transferrable.

The supervisor of the order managers and order processing managers found that one of the order managers scores too high regarding three knowledge areas, namely: electrical engineering; organization and business processes; and PC and software. According to the supervisor, the knowledge and experiences of this employee are one or two levels lower for the three mentioned areas. The order manager indicates higher scores than the manager has in mind, because he looks at one of the elements within a knowledge area. However, an employee should have knowledge and experience about all the aspects that belongs to the knowledge areas. In addition, two order processing managers assess themselves with lower scores than the manager does. For one of them this is related to the knowledge area PC and software and the other order processing manager scores lower on mechanical engineering and materials; and Dutch, English and German. Here, there is a difference of one knowledge and experience level. The scores of the other employees correspond to what the supervisor expected. In addition, the supervisor found it difficult to assess the answers related to the transfer of knowledge and experience, because he supposed that this is more subjective.

The application engineers reported that some of the knowledge areas are too general. This is mainly about the knowledge area product portfolio of Eaton for low- and medium voltage. The question is: what products are included in the product portfolio? Thereby, it should be recognized that these products are described in the skill matrix of the application engineers. There is one employee who declared that all knowledge areas are too general. This employee was also reluctant with regard to how the information will be used in the future.

The order managers and order processing managers had no difficulty in completing the knowledge-experience matrix. The only comment of one of the order managers was that the knowledge areas electrical engineering and PC and software are too broad. The recommendation was to divide certain knowledge areas into new areas. An example for electrical engineering is to divide electrical engineering into two knowledge areas. More specifically, low voltage techniques, automation, PLC techniques and security technique can be one area; medium voltage techniques and Scada application form the second knowledge area.

Overall, twelve employees completed the matrix. This can be seen as a good start in the knowledge mapping process. It gives a first impression about the knowledge and experience levels within a particular function. However, the evaluation indicates a few minor adjustments. It might be better to test the matrix again after the adjustments have been carried out; due to time constraints it was not possible in this research. On the basis of the discussion (chapter 6) and the recommendations (chapter 7) Eaton can test and implement the tool as well as possible taking the adjustments into account.

6. Discussion

The discussion starts with a reflection of the tool, which is less focused on the organization. It is more a general reflection of the tool. Furthermore, the discussion contains a reflection on the outcomes, the required knowledge, the knowledge areas, the evaluation and the dynamic character of the tool. The last section of this chapter addresses the possibilities and limitations of the tool in comparison with the existing tools described in chapter 4.

6.1 General reflection

In this research a tool is developed, which can also be used by other organizations. In other words, it is a generic tool to map knowledge. The tool focuses on the first step of knowledge management, which is the identification of knowledge that exists in a target area (Liebowitz et al, 2000). To be more specific, it is about the available knowledge of employees (Anand & Singh, 2011). The tool consists of two core elements of the human capital aspect that are integrated in the tool, namely knowledge and work experience (Marr, 2008). Knowledge and experiences are both included, because an employee can obtain much knowledge during a study, but this cannot always be used in practical situations. Therefore, it is necessary for employees to gain work experience in 'real' situations (Liefhebber et al., 2010). The next step of knowledge management, knowledge transfer, is also partly included in the tool (Weggeman, 1997). Here, the distinction between implicit and explicit knowledge becomes clearer, which is a common classification of knowledge (e.g. Boersma, 2002). Employees have knowledge that can be expressed in words (explicit) and personal knowledge (implicit). In general, implicit knowledge is more difficult to transfer than explicit knowledge, since it is hard to formalize (Nonaka, 1991).

To map knowledge with the new tool an organization define knowledge areas that contain specific knowledge related to the strategy, mission, vision and objectives of a company (van Daal et al., 1998). Besides to the knowledge areas, an organization determine the required knowledge which is related to knowledge that is necessary to survive and continue with the activities (Boersma, 2002). Managers can determine the needed knowledge and experience levels for the knowledge areas. On the basis of the knowledge areas employees can specify their knowledge and experience level. This allows the organization to compare present knowledge with required knowledge. This results in knowledge gaps, i.e. there is a negative difference between the available and required knowledge. In addition, they can indicate whether it is easy or difficult to transfer knowledge and experiences. The tool provides managers the possibility to identify risks within a function or the risks for a particular knowledge area. For instance, is there sufficient knowledge and experience available within a function of the company? The tool also shows the employees that are of crucial importance for an organization. If this is the case, employees have much knowledge and experiences about the knowledge areas. The tool can also be used for the next step of knowledge management, since it represents the difficulty to transfer knowledge and experiences. Knowledge transfer is mainly focused on employees with a high level regarding their knowledge and experiences, since the aim is to keep crucial knowledge inside the company. In other words, employees with much knowledge and experiences are important for an organization.

To summarize, what is the end results of the tool in general?

- An overview of crucial knowledge areas.
- A representation of knowledge areas with the associated knowledge and experience levels of employees.
- The identification of employees with a high knowledge and experience level, which are important for the organization.
- The tool discovers knowledge gaps and risks within functions or per knowledge area.
- The organization get a simple tool that allows managers to develop and maintain the knowledge and experience levels of employees.
- The tool gives an indication about the difficulty to transfer knowledge and experiences.
- The tool is a first step in knowledge management, which can be used to continue with the next steps of knowledge management.

6.2 Reflection on the current research

This section is divided into two subsections. First of all, there is a reflection on the outcomes, because some answers possibilities are not used. In addition, development can play an important role when employees have low knowledge and experience levels. Second, there is attention paid to the choices made with regard to determining required knowledge, knowledge areas and the applied evaluation. As last, the dynamic character of the tool is described.

6.2.1 Outcomes of the tool

As mentioned before, the discussion continues with a reflection on the answers given in the matrices, followed by a reflection on the degree of work experience and the knowledge gaps. It can be important to develop employees when knowledge and experiences are insufficiently available. An organization can maintain the knowledge and experience levels of employees. In addition, knowledge transfer can be used to keep crucial knowledge in the company.

Answers matrix

It is remarkable that none of the employees the knowledge level '*no knowledge'* has marked. The employees can have the thought that they will be judged on the completed matrix, which might have certain consequences. However, the aim of the tool is to map knowledge and identify employees with much knowledge and experiences. Furthermore, for the degree of experience the answer *'beginner'* is only three times used. A reason may be that employees change jobs more frequently (Tesluk & Jacobs, 1998). Employees work in several jobs and/or companies during a relatively short period, which can support in obtaining more knowledge and work experience. Nevertheless, in the evaluation the supervisors indicated that the employees who filled in the matrix have a knowledge level higher than *'no knowledge'* and an experience level higher than *'beginner'*. The answers for the transfer of knowledge and experiences are less conspicuous partly because each answer possibility is used. Though, there are employees who primarily answer with *'average'*. It does not mean that it is right or wrong, but a clearer explanation of the content can contribute to a proper interpretation of the matrix. This also applies to the supervisors, because a better understanding of the content can provide support in assessing the results. Afterwards, the introduction in this research added to the matrix is perhaps not clear enough for employees. Besides, managers must understand what the content of the matrix implies. This means that the managers need to invest time in order to gain more insight in knowledge mapping and transfer.

Degree of work experience

We will now discuss the degree of work experience with regard to the individual level. It is important to know which aspects influence the development of work experience, since employees with crucial experience can share it with others that have a lower experience level. Besides, there are methods which can be applied to develop experiences. As a result, the experience level can be increased. Experiences are often seen in combination with tenure. There are studies that measure work experience in quantitative terms based on years in a job, years in an organization or years in a position (e.g. Borman, Hanson, Oppler, Pulakos and White, 1993). However, tenure has not always the same impact on individuals, since performance of employees can be improved or deteriorated during a particular employment. Here, work experiences are related to qualitative terms. Thus, time is an aspect of work experience, but there are also other factors that play a role. Tesluk and Jacobs (1998) describe contextual and individual factors that influence the development of work experience. A method to develop experiences is job rotation, which can contribute to obtain work experience and develop relationships with other employees (Bennett, 2003). The work situation can also have an effect on the development of an employee's work experience (Tesluk & Jacobs, 1998). Supervisors can use mentoring or training to develop experiences of subordinates. In addition, experiences gained from outside the work can be used for the current job. There are also personal characteristics that might have an impact on the work experience. Employees with a higher level of ability acquire more often experiences than when they have a lower ability level. Furthermore, the authors stated that self efficacy and motivation to learn have influence on updating experiences. To conclude, obtaining work experiences is not only dependent on time, because contextual and individual factors can also affect the degree of work experience. A consequence might be that not every employee has the same desire to develop experiences. Though, the supervisor can create a supportive work environment where employees feel comfortable to use new experiences (Tesluk & Jacobs, 1998).

Knowledge gaps

Knowledge gaps can be identified by using the tool. Haider (2003) defines a knowledge gap as *'all types of organizational knowledge which a company currently lacks but identifies to be critically important for its survival and growth and, hence, need to be filled'* (p. 11). In simple words, a knowledge gap is the gap between '*what a firm must know and what the firm does know'* (Albers, 2009). This also includes the knowledge of employees, which can be applied to the tool, because it identifies present and required knowledge. But the question is how can an organization deal with possible knowledge gap? In this research the focus is on knowledge management. Knowledge development and transfer are part of knowledge management, which can be used to overcome knowledge gaps. There are different mechanisms that can be used to transfer knowledge. Argote, Ingram, Levine and Moreland (2000) give a list of methods, namely personnel movement; training; communication; observation; technology transfer; routines; presentations; and publications. Knowledge levels can be increased by means of the development of employees or by mutually knowledge sharing. This allows an organization to maintain knowledge levels and keep knowledge within a company.

In table 3 an overview of specific methods is given that can be used to develop or share/transfer knowledge (Kessels & Smit, 2000; Nonnekes, 2005).These methods are included, because it is a more practical interpretation of knowledge development and transfer methods.

Methods	**Knowledge development**	**Knowledge sharing and transfer**
On the job training or workshops	X	
Simulation as a training technique (practice, experimentation and learning)	X	X
Personal development plan	X	
Job rotation	X	X
Coaching to develop new skills and knowledge	X	
Face-to-face communication with two or more employees, e.g. through work meetings or presentations		X
Using a medium to realize knowledge transfer, e.g. communities, wikis, intranet, e-mail or discussion lists		X
Experts within the organization can be used to teach or coach others		X
Observation and imitation of experienced employees (insight into how a process works)		X
Make experiential knowledge visible by interviewing experts, so that it can be shared to other employees (also exit interviews)		X

Table 3: Overview of methods for knowledge development and knowledge transfer

6.2.2 Choices made in the research

It is important to reflect on the choices made in the current research, because it might be possible that there are other perhaps more effective ways to determine the required knowledge and knowledge areas. In addition, there is a reflection to assess whether the evaluation needs to be adjusted. Lastly, the dynamic character of the tool should be taken into account.

Determination of required knowledge

In this study the required knowledge is established on 60% or higher. This means that employees should have specialized or expert knowledge and are proficient or expert in terms of work experience. The limit of 60% is chosen, because the tool is tested and not implemented in the organization. There are three functions, application engineer, order manager and order processing manager, which are part of the test phase. From these functions, a number of employees are selected to complete the matrix. However, not every employee within the functions filled in the matrix, making it difficult to determine the required knowledge for the entire function. If each employee within a function participates in completing the matrix the required knowledge can be determined in a different and more realistic way. For example, managers can determine how many

employees must have specialized or expert knowledge (>60%) per knowledge area. In other words, the required knowledge levels can be indicated for each knowledge area. Thereafter, managers can check whether the required knowledge is available among employees within a function. This also applies to other companies, because it is a generic tool that can be used in every organization.

Determination of knowledge areas

In the current research the knowledge areas are established by a manager and two supervisors. Employees are not involved in the formulation of the knowledge areas. However, the evaluation showed that employees found the knowledge areas too broad/general. Employees might have problems by indicating their knowledge and experience level when knowledge areas are too general. Therefore, managers can determine knowledge areas, which can be discussed in a work meeting. In the work meeting employees can give their input about the knowledge areas. In addition, employees will have the opportunity to give suggestions to make the knowledge areas as specific as possible. Though, it is not advisable to create too much knowledge areas, otherwise it becomes an extensive tool. The percentages for the different knowledge and experience levels can be explained in more detail. Employees can indicate their knowledge and experiences based on percentages, for example an employee has 80% knowledge of all the elements within a certain knowledge area, which makes this person an expert. As a result, employees are probably better able to indicate their knowledge and experience levels.

The applied evaluation

Employees within an organization are the persons who complete the matrix. They indicate their knowledge level, experience level and the difficulty to transfer knowledge and experiences. In this research the results are evaluated with the supervisors. Generally, the results are consistent with the expectation of the supervisors. According to the supervisors, a few adjustments were needed, because five employees scored too low on a number of knowledge areas. There was one employee who scored one or two levels higher than the supervisor expected. This study did not examine the causes for these differences in perceptions. It is probably more effective that a manager determines the knowledge and experience levels of employees, before the workers complete the matrix. Thereafter, employees can fill in the matrix. The results of the matrices can be compared with the perception of the manager. This gives a more realistic view of differences that exist between the expectation of the manager and the results of the employees. The differences can be discussed during a work meeting, where both managers and employees can explain why they choose a particular knowledge or experience level. This increases the value of the evaluation, because the managers and employees can discuss the scores with each other. Finally, the reliability of the scores might increase if both managers and employees can give their opinion about the results.

Dynamic character of the tool

Van Daal et al (1998) developed the knowledge matrix which is not a static, but a dynamic tool. The same applies to the knowledge-experience matrix developed in this research. The dynamic character of the tool is caused by changes inside and outside the organization. Changes in an organization's environment can ensure that the strategy of an organization needs to be adjusted. This affects the knowledge areas in two ways, namely new knowledge areas can be added to the matrix and knowledge areas that are no longer of interest can be removed (Boersma, 2002). The required knowledge should also be reassessed for the new knowledge areas. After the new areas are defined employees complete the matrix again to identify their knowledge and experience level regarding the

new knowledge areas. In addition, knowledge levels within the organization can change by means of knowledge development, knowledge transfer or hiring new employees. Knowledge development or transfer can ensure that knowledge levels of employees increase. Furthermore, changes in the environment can lead to certain knowledge that is not available in the organization, making it perhaps more useful to obtain knowledge from outside the organization. Here, the economic situation should be taken into account, because an organization needs the resources to gain knowledge from outside. An option to acquire knowledge is to hire new employees, which have the needed knowledge. Hiring employees affect the knowledge levels in a company. Thus, it is important for organizations to properly maintain the matrix, taking the changes from inside and outside the company into account.

6.3 Possibilities and limitations of the tool

This last section describes the possibilities and limitations of the tool also in comparison with the existing tools described in chapter 4. The knowledge audit (Liebowitz et al., 2000), the roadmap to develop a knowledge map (Kim et al., 2003) and 'Identick' (Blaauw, 2005) contain complex or extensive steps to map knowledge. The knowledge-experience matrix, developed in this research, has the possibility to quickly and easily map knowledge of employees. It is a simple tool consisting of a small number of steps that are easy to carry out. These steps are: defining the knowledge areas; completing the matrix; and evaluating the results. Employees with much knowledge and experiences, which are crucial for an organization, can be identified. In addition, there are no difficult techniques needed to analyze the results, because colors are used to indicate the knowledge and experience levels of employees. This provides a clear representation of the levels of employees. The tool also provides an organization the possibility to detect knowledge gaps or risks quickly. An organization can decide to reduce the knowledge gaps and risks to maintain the knowledge levels of employees. As last, the tool also addresses the difficulty to transfer knowledge and experiences. If an employee with much knowledge and experience leaves the tool can be used in order to determine whether it is difficult to transfer knowledge, which affects the time needed to complete the transfer.

There are also some limitations of the tool in comparison with the existing tools. The matrix represents knowledge areas that consist of knowledge which is crucial to follow an organization's strategy. These knowledge areas are concisely described in the matrix, making it perhaps difficult for employees to complete the matrix, which can be a limitation of the tool. Knowledge extraction is a more comprehensive that belongs to the roadmap to develop a knowledge map (Kim et al., 2003). It examines the prerequisite knowledge before a process is executed and the knowledge used during the process. As a result, the knowledge areas become more specific and it is probably easier for employees to complete the matrix. To extract knowledge different techniques can be applied, such as interviews, document analysis, system analysis and knowledge workshops. Another limitation of the matrix is that it only identifies the knowledge and experience levels of employees without paying attention to how an employee has obtained the knowledge and experiences. It is important to know how knowledge and experiences are obtained by key employees, because it can contribute to knowledge development and knowledge transfer. This process is part of the instrument developed by Blaauw (2005). The author describe that knowledge can be obtained through education or experience. Aspects that play a role are: followed courses, level of education and diplomas. Furthermore, it should be defined how an employee gained his experience. A method to make knowledge visible is to interview experts. It provides more insight about the specific knowledge and experience of experts.

7. Conclusions and recommendations

This final chapter provides an answer to the central research question and it will discuss the added value of knowledge mapping and knowledge management. In addition, conclusions are given based on the test phase of the matrix. Thereafter, recommendations are formulated for Eaton with regard to the implementation of the tool. The next steps will also briefly discussed, which can be used to embed knowledge management in the organization.

7.1 Knowledge mapping tool for Eaton

This section is dedicated to answering the main question. The research question which guided this study is:

How can a new tool be developed in order to map the present and required knowledge of the employees of Eaton Industries B.V.?

This research can be defined as design-oriented research. On the basis of the problem definition, the analysis and diagnosis step and the plan of action the central research question can be answered. It all starts with the problem that exists within Eaton. It is important to determine whether there is a real problem and a new tool is necessary to overcome this problem. Therefore, interviews have been conducted, which showed that there are changes in the workforce namely aging, a low inflow of (young) technical employees and natural outflow. The outflow can cause a loss of knowledge. In addition, Eaton is more dependent on the current employees and their knowledge levels. Thus, it is important for Eaton to map present and required knowledge to keep knowledge inside the organization and to maintain the knowledge levels.

The literature review has been carried out to determine which elements are useful to design the tool. Two approaches, knowledge management and intellectual capital, have been reviewed. The conclusion is that knowledge management is more a process where knowledge-related activities play a central role. The purpose is to make knowledge visible and accessible to others (Anand & Singh, 2011). This is part of knowledge mapping, which is used to identify knowledge and discover where crucial knowledge resides. Intellectual capital contains an extensive description about the knowledge-related resources, which are crucial for a company. Thus, knowledge management is used to start with the identification of knowledge. The intellectual capital perspective has given more insight in the mapping components. The result is that knowledge and experiences are mapped.

Thus, how can a new tool be developed to map knowledge? For the design of the new tool there are different existing methods compared. The knowledge matrix of van Daal et al. (1998) is taken into account, because this tool also maps knowledge. The authors make use of knowledge areas. The first step of the process described in the knowledge audit (Liebowitz et al., 2000) is also a useful part for the new tool, because it is related to the identification of knowledge. In addition, the requirements from Eaton are used to design the tool. The result is a matrix where knowledge and experiences levels are the key aspects. The first part is the determination of crucial knowledge areas, which are related to the mission, vision, objectives and strategy of Eaton. The preference is to specify the content of the knowledge areas, which is applied in the matrix. Then the employees have a clearer view of what knowledge is required. Furthermore, the assumption is that they are better able to indicate their knowledge level and degree of experience. The next part of knowledge management is partially examined by including the difficulty to transfer knowledge and experiences. This can add

value, because it can contribute to knowledge development or transfer, which means that knowledge levels can be increased and crucial knowledge can be kept inside the organization.

To test the tool managers of the front-end departments were contacted. Finally, the matrix is completed by six application engineers, three order manager and three order processing managers, which are part of the front-end departments. The results have led to a first impression of the knowledge and experience level of employees. The overall conclusion is that the matrix is an instrument to identify the knowledge levels and degree of experiences with regard to the crucial knowledge areas.

7.1.1 The added value of knowledge mapping and KM

This research focuses on the development of a tool to map present and required knowledge of employees from Eaton. On the basis of the research, it can be concluded why knowledge mapping and knowledge management are important for Eaton. Knowledge mapping or the identification of knowledge can support the organization to find out where crucial knowledge is situated. A tool to map knowledge can be used to identify knowledge stocks and knowledge gaps (Egbu & Suresh, 2008). Comparing available knowledge with required knowledge ensures that training opportunities arise to overcome these knowledge gaps (Soliman & Spooner, 2000). In other words, it is important for managers to identify what knowledge their department has and where the risks are located. The risks mean that there are not enough employees within a certain department or function that have sufficient knowledge and experience. Thus, knowledge mapping allows the organization to maintain the knowledge levels of employees and can help in reducing the risks. A manager can also decrease risks, for example when there is only one specialist in a particular knowledge area. Hereby, the HR department can be supportive regarding training and development programs. The development of knowledge is one of the tasks of knowledge management (King, 2009).

But why can knowledge management add value for Eaton? The new tool provides the possibility to identify crucial employees that have a high knowledge level and degree of experience. This can also be applied for the key functions of Eaton, because these positions are essential for the core business. The ultimate purpose is to retain or store crucial knowledge, which means that other employees can learn from or make use of the knowledge from the experts within the organization. It is quite possible that problems can be solved quicker and tasks can be performed faster if employees can find the knowledge they need. In addition, if employees leave Eaton in the current situation the knowledge is not mapped or transferred. Thus, knowledge management can also be meaningful in the transfer of crucial knowledge to other workers. The result is that these employees can apply the crucial knowledge. Therefore, the difficulty of knowledge and experience transfer is included. If transfer is taken place, managers can use the matrix to check whether it is easy or not. This influences the time needed to complete the transfer. In general, the chance that crucial knowledge leaves the organization will be reduced by transferring knowledge. Furthermore, knowledge transfer can contribute to the increase of knowledge levels.

7.2 Conclusions test phase

In the conclusions attention is paid on the time issue that plays a role in the test phase, the results of the completed matrices and the advices of the employees regarding adjustments of the tool.

Time issue

First of all, it has been found that time is an important issue within Eaton. Some employees were busy with their own tasks and they had no time to participate in completing the matrix. If Eaton decides to embed knowledge management in the organization, it is essential that all employees within a function want to participate. Furthermore, the supervisors had also a lack of time, whereby the support was less than expected. This is also mentioned in the literature about HR responsibilities and line management. It can be that line managers have not enough time to deal with HR tasks (Larsen & Brewster, 2003). Overall, the results are evaluated with the supervisors, but it might be better to take more time to evaluate the results in detail together with the employees. When employees and managers do not want to spend much time or effort to map knowledge it is useless to implement knowledge management in the organization.

Conclusion from the results

The results of the completed matrices have shown that there is an application engineer and an order manager with crucial knowledge and experiences. In other words, these two employees have more than 60% knowledge and experiences about almost all knowledge areas. Thus, there is a risk that the crucial application engineer and order manager with corresponding knowledge leave Eaton. This does not apply to the order processing managers. From the three orders processing managers there is no employee with sufficient knowledge and experiences about all knowledge areas. The function order processing manager has already a problem, because of a lack of knowledge and experiences. In general, there are knowledge gaps among employees of all three functions, because not everyone has sufficient knowledge and experience. Therefore, knowledge transfer are important to keep the knowledge 'in-house' and also for increasing the knowledge levels. A side note is that the conclusions are based on the employees that were part of the test phase. This may give a biased effect, because not all employees of the three functions have filled in the matrix. Concluding, each employee within a function should participate in the process of knowledge identification. Otherwise, the managers do not have a realistic view of the results in relation to the knowledge and experience level of the employees within a function.

Advice of the employees

The evaluation with the employees regarding the content of the tool has led to potential adjustments. Several employees of the three functions found that a number of knowledge areas are too general. The consequence is that some of the employees had difficulties to indicate their knowledge and experience level. Therefore, the results are evaluated with the supervisors. For the employees it is essential that the knowledge areas or the introduction before completing the matrix should be made clearer. If employees better understand the content of the tool it will be easier to complete the matrix. Another issue is that a number of employees were reluctant regarding the privacy of the data. They do not want that the information will be made public in the whole organization. From this, it can be concluded that the introduction should be adjusted in order to better inform the employees. In addition, it might be more effective to involve employees with regard to the determination of knowledge areas (see section 6.2.2).

7.3 Recommendations

The recommendations refer to the vision and approach of knowledge management, the implementation of the tool, the creation of awareness and the next steps after the knowledge mapping phase.

Knowledge management vision

Eaton can start with the creation of one vision regarding knowledge management. This is also the case for the implementation of the different steps belonging to the knowledge management approach. What does an organization wants to achieve by implementing knowledge management? The HR department must agree on the plan that knowledge management will be further embedded in the organization. The HR department can be seen as starting point to perform the steps of knowledge management. If HR can give a good explanation of knowledge management, it is likely that the managers will understand the necessity for the organization. As a result, the motivation of managers can increase (Bos-Nehles, 2010). Otherwise, if HR is not concerned with knowledge management the chance of success will decrease. In the future, it is intended that the managers can apply knowledge management by themselves. Therefore, the support of HR is very important in the begin phase also to develop a vision by the managers.

The above description also means that the reasoning and processes of knowledge management must be defined. The general thought of knowledge management '*relates to unlocking and leveraging the knowledge of individuals so that this knowledge becomes available as an organizational resource'* (Anand & Singh, 2011, p. 932). From the literature review there are four key processes with related tasks (Alavi & Leidner, 2001; Anand & Singh, 2011). These processes are: knowledge creation (identification and development of knowledge); knowledge storage (transforming knowledge in a codified form); knowledge transfer (sharing knowledge to all employees) and knowledge application (using knowledge). The processes need to be followed when knowledge management will be introduced.

Implementation knowledge-experience matrix

The following step, after the creation of one vision, can be the allocation of responsibility to the persons who are going to implement knowledge management. Initially, a project group can be set up by including employees of HR. Other managers or employees can also be involved in the project group. This group can create awareness and commitment by the members of the leadership team (LT) and management team (MT). Therefore, practical issues which influence managers to carry out HRM activities should be taken into account. Issues that are relevant for this study are a lack of time to deal with these activities, the short-term focus and ignorance in recent developments (Larsen & Brewster, 2003). These issues are also mentioned in the conversation with the plant manager. In addition, the supervisors had a lack of time to provide full support. Bos-Nehles (2010) describes in her dissertation constraints of line managers' HR performance. Capacity and desire are two constraints, which are applicable for this research. The researcher found that line managers solve the capacity problem by delegating tasks or responsibilities to experienced employees or carry out the tasks outside the office hours. The managers of Eaton can delegate tasks to overcome the time issue. A lack of desire can be reduced by external motivation. If managers realize that the HR tasks are relevant, they can be more motivated to perform these tasks. Therefore, the project group of Eaton can support the managers to show that there are changes in the workforce, which have an impact on the knowledge level of the company. In addition, crucial knowledge can be identified and

kept inside the company by means of retention and transfer. It prevents a potential loss of crucial knowledge. This also means that managers have to be informed of the next steps of knowledge management. Overall, it should be mentioned that the project group and the LT and MT need to invest time to embed knowledge management in the whole organization.

The employees should also be motivated to map their knowledge and participate in the knowledge management process. They are in fact the persons who are central, because employees fill in the matrix. Thus, the creation of awareness among employees is also important. After completing the matrix an employee can see the status quo of the own knowledge and experience level. Eventually, they are eligible for development to improve the knowledge level and extending the work experience. Either knowledge of experts can be transferred to an employee with a lower knowledge level. Furthermore, if employees contribute to the knowledge management process, they can use knowledge of others, when it is stored in a central system. In general, to motivate employees to transfer knowledge it is useful to show employees that knowledge exchange can create value, the knowledge self-efficacy can be improved and employees can support others or provide knowledge that is important for the organization (Lin, 2007).

Once awareness has been created by the employees and managers the crucial knowledge areas can be determined. It is almost impossible and time-consuming to define the knowledge areas of all the functions from the plant in Hengelo. An advice is to start with the knowledge areas of the key positions, because these are the most crucial for Eaton. The key functions can be determined by the members of the LT and MT. The managers can, along with the supervisors, determine the knowledge areas, because they have to think about what knowledge is needed within the department. In addition, the intention is to make the knowledge as specific as possible. The employees gain a better view of what is expected from them in the field of knowledge. Therefore, the established knowledge areas can be discussed in a work meeting where employees are able to give feedback or suggestions. A remark is that the knowledge areas must be linked to the MVOS of Eaton. Finally, when the knowledge areas are determined the employees can start with completing the matrix. In the begin phase HR can support the managers, but the aim in the future is that managers indentify knowledge of their department by themselves.

Another important point is the number of knowledge areas. What matters is that the knowledge, which is crucial for Eaton, is part of the content of the knowledge areas. A guideline of 10 or 12 knowledge areas can be used by Eaton. These numbers of knowledge areas reduce the risk that the tool becomes too complex. Furthermore, this ensures that managers only reflect on the crucial knowledge of their department. Finally, it will take less time for employees to fill in the matrix.

A possibility for Eaton is to combine the knowledge-experience matrix with the existing skill matrix. As mentioned in chapter 5 the skill matrix contains technical skills, commercial skills, systems and tools of Eaton and other skills. The knowledge-experience matrix is more about knowledge areas consisting of specific knowledge, which employees should have. The two matrices can be combined by means of the creation of one common matrix also because skills are part of knowledge. In this matrix, both the most important knowledge areas and skills can be included to identify the levels of employees. The organization prevents that employees must complete each matrix separately, which also takes more time. Thus, the common matrix gives a complete overview of the knowledge levels, experience levels and skill levels of employees.

Next steps in the knowledge management process

After the identification of knowledge Eaton can continue with the next steps of knowledge management, namely store and transfer knowledge. In the previous chapter different methods are described for knowledge transfer. For example, Eaton can interview experts to make knowledge visible. Thereafter, the knowledge can be stored and shared with others by implementing a digital system. A few months ago a start was made with the program Microsoft SharePoint. At the moment, Eaton paid no attention on the development of SharePoint, while the program might be very useful. Microsoft SharePoint is a web application, which can be used to make the cooperation between employees easier. Employees can build websites with the aim of searching and sharing information, managing documents and publishing reports (Microsoft Office, n.d.). There is a HR employee from Austria who introduced SharePoint at the location in Vienna. This employee is prepared to support the HR department in Hengelo to implement SharePoint. It can add value, because knowledge can be retained in the system and employees can share information with each other in a simple way. In addition, each department can develop its own SharePoint. This means that it is not necessary to disclose confidential information. Employees can put information on SharePoint by themselves to keep it up to date. Thus, knowledge can be retained and shared within a department or even the whole organization. SharePoint is also useful, because existing systems can be added to the system. For example, Eaton works with APEX, which is a method to translate organizational goals into individual goals that include personal development with the overall goal to improve individual and organizational performance (Electrical Solution & Services, 2011). Thus, APEX can be added to the SharePoint system. This also applies to the skill matrix of Eaton, so that it can be combined with the knowledge-experience matrix.

One of the requirements also discusses the maintenance of the tool. The matrix is stored in a Word document. This document can be updated every year and employees are asked to complete the matrix again. The problem is that much paperwork or documents are involved. With the aid of SharePoint the tool will be more maintenance-friendly, because employees have the possibility to add or change information. The proposal is that the tool will be revised annually to make adjustment when it is needed. The managers also have to keep the knowledge areas up to date by reviewing the areas every year. The knowledge areas must also be adjusted when the strategy of Eaton changes. It takes less time for employees to add or change information, because it is a digital system.

References

Abdullah, R., Ibrahim, H., Atan, R., Napis, S., Selamat, M.H., Hairudin, N.H., & Hamidon, S.H. (2008). The Development of Bioinformatics Knowledge Management System with Collaborative Environment. *International Journal of Computer Science and Network Security,* 8 (2), p. 309-319.

Aken, J. E., van. (2004). Management research based on the paradigm of the design sciences: the quest for field-tested and grounded technological rules. *Journal of management studies*, 41(2), p. 219-246.

Aken, J.E. van, Berends, H. & Bij, H. van der. (2007). *Problem solving in organizations: A Methodological Handbook for Business Students.* Cambridge University Press.

Alavi, M. & Leidner, D.E. (1999). Knowledge management systems: issues, challenges, and benefits. Communications of the Association of Information Systems, 1 (7), p. 1-37.

Alavi, M. & Leidner, D.E. (2001). Review: Knowledge Management And Knowledge Management Systems: Conceptual Foundations And Research Issues, Management Information Systems Research Center, 25 (1), p. 107-135.

Albers, J. A. (2009). A practical approach to implementing knowledge management. *Journal of Knowledge Management Practice*, 10 (1), p. 1-14.

Anand, A. & Singh, M.D. (2011). Understanding Knowledge Management: a literature review. *International Journal of Engineering Science and Technology,* 3 (2), p. 926-939.

Argote, L., Ingram, P., Levine, J. M., & Moreland, R. L. (2000). Knowledge transfer in organizations: Learning from the experience of others. *Organizational Behavior and Human Decision Processes,* 82 (1), p. 1-8.

Babbie, E. (2007). *The practice of Social Research.* Eleventh Edition, Thomson Wadsworth.

Baumgart, M., Houri, M. Y., Rückstieß, T., & Sehnke, F. (2007). Research Methods in Informatics and its Applications: Design-Oriented Research.

Beirendonck, L. van, (2004). *Iedereen competent*. Lannoo Uitgeverij.

Bellinger, G., Castro, D., & Mills, A. (2004). Data, Information, Knowledge, and Wisdom. Retrieved on October 18, from: http://courseweb.lis.illinois.edu/~katewill/spring2011-502/502%20and%20other%20readings/bellinger%20on%20ackoff%20data%20info%20know%20wisdom.pdf

Bennett, B. (2003), "Job rotation", *Development and Learning in Organizations*, 17 (4), p. 7-9.

Berenschot, (2011). Rapportage van de Ken- & Stuurgetallen vragenlijst: Duurzaam Meedoen in de Metalektro, p. 1-14.

Blaauw, G. (2005). *Identificatie van Cruciale Kennis.* Proefschrift Rijksuniversiteit Groningen. Ridderkerk: Labyrint Publications.

Boersma, J. (2002). *Management van kennis: Een creatieve onderneming.* Koninklijke Van Gorcum, Assen.

Borman, W. C., Hanson, M. A., Oppler, S. H., Pulakos, E. D., & White, L. A. (1993). Role of early supervisory experience in supervisor performance. *Journal of Applied Psychology*, 78 (3), p. 443-449.

Bos-Nehles, A. C. (2010). *The line makes the difference: line managers as effective HRM partners*. University of Twente.

Bryman, A. (2012). *Social research methods*. OUP Oxford.

Burg, E. van, (2011). Kwaliteitscriteria voor ontwerpgericht wetenschappelijk onderzoek. In J. van Aken & D. Andriessen (Eds.). *Handboek ontwerpgericht wetenschappelijk onderzoek: Wetenschap met effect,* p. 146-164. Den Haag: Boom Lemma.

Burnett, S., Illingworth, L., & Webster, L. (2004). Knowledge Auditing and Mapping: A Pragmatic Approach. *Knowledge and Process Management,* 11 (1), p. 25-37.

Cabrita, M.R., & Bontis, N. (2008). Intellectual capital and business performance in the Portuguese banking industry. *Intellectual Capital and Business Performance,* 43 (1-3), p. 212-237.

Cabrita, M.R. & Grilo, M.A. (2012). Linking Knowledge Management and Intellectual Capital: An Evidence Based on Portuguese Banks Study. *International Conference on Innovation, Management and Technology Research,* Malacca, Malaysia.

Chan, K.H., Chu, S.K.W., & Wu, W.W.Y. (2012). Exploring the Correlation Between Knowledge Management Maturity and Intellectual Capital Efficiency in Mainland Chinese Listed Companies. *Journal of Information & Knowledge Management,* 11 (3), p. 1-11.

Chan, P.C.W. & Lee, W.B. (2011). Knowledge Audit with Intellectual Capital in the Quality Management Process: An Empirical Study in an Electronics Company. *The Electronic Journal of Knowledge Management,* 9 (2), p. 98-116.

Chan, K. & Liebowitz, J. (2006). The synergy of social network analysis and knowledge mapping: a case study. *International Journal Management and Decision Making,* 7 (1), p. 19-35.

Chou, S-W. (2005). Knowledge creation: absorptive capacity, organizational mechanisms, and knowledge storage/retrieval capabilities. *Journal of Information Science,* 31 (6), p. 453-465.

Corbin, J., & Morse, J. M. (2003). The unstructured interactive interview: Issues of reciprocity and risks when dealing with sensitive topics. *Qualitative inquiry*,9 (3), p. 335-354.

Daal, B. van, Haas, M. de & Weggeman, M. (1998). The Knowledge Matrix: A Participatory Method For Individual Knowledge Gap Determination. *Knowledge and Process Management,* 5 (4), p. 255-263.

Daud, S. & Yusoff, W. F.W. (2011). How intellectual capital mediates the relationship between knowledge management processes and organizational performance. *African Journal of Business Management,* 5 (7), p. 2607-2617.

Davenport, T.H. & Prusak, L. (1998). *Working Knowledge: How Organizations Manage What They Know.* Harvard Business School Press, Boston, Massachusetts.

Dayan, R. & Evans, S. (2006). KM your way to CMMI. *Journal of Knowledge Management,* 10 (1), p. 69–80.

Dean, A., & Kretschmer, M. (2007). Can ideas be capital? Factors of production in postindustrial economy: a review an critique. *Academy of Management Review*, 38, p. 1-30.

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. *Medical education*, 40 (4), p. 314-321.

Edvinsson, L. (1997). Developing Intellectual Capital at Skandia. *Long Range Planning*, 30 (3), p. 366-373.

Egbu, C. & Suresh, S. (2008). Knowledge Mapping Techniques Within The Construction Industry: An Exploratory Study. In: Information and Knowledge Management in Buildings*,* Finland, June, p. 48-57.

Electrical Solutions & Services, (2011). Eaton Business Excellence Application Information Form, *EBEA Application.*

Eppler, M.J. (2001). Making Knowledge Visible Through Intranet Knowledge Maps: Concepts, Elements, Cases. *Proceedings of the 34th Hawaii International Conference on System Sciences,* p. 1-10.

Eppler, M. J. (2006). Toward a pragmatic taxonomy of knowledge maps: classification principles, sample typologies, and application examples. *Information Visualization, Tenth International Conference* p. 195-204.

Fallman, D. (2007). Why Research-Oriented Design Isn't Design-Oriented Research: On the Tensions Between Design and Research in an Implicit Design Discipline. *Knowledge, Technology & Policy*, 20 (3), p. 193-200.

Grey, D. (1999). Knowledge mapping: a practical overview. *SWS Journal.*

Haider, S. (2003). Organizational Knowledge Gaps: Concept and Implications. In *Druid Summer Conference*, p. 1-24.

Heng, M.S.H. (2001). Mapping intellectual capital in a small manufacturing enterprise. *Journal of Intellectual Capital,* 2 (1), p. 53-60.

Hsu, Y.H. & Fang, W. (2009). Intellectual capital and new product development performance: The mediating role of organizational learning capability. *Technology Forecasting and Social Change,* 76, p. 664-677.

Jafari, M., Akhavan, P., Bourouni, A. & Amiri, R.H. (2009). A Framework For The Selection Of Knowledge Mapping Techniques. *Journal of Knowledge Management Practice,* 10 (1), p. 1-13.

Kessels & Smit (2000). Werken aan kennis: Methoden voor het creëren, delen en toepassen van kennis, Retrieved on February 22, 2013 from http://www.kessels smit.nl/files/2000_instrument_werken_aan_kennis.pdfp.

Kim, S., Suh, E. & Hwang, H. (2003). Building the knowledge map: an industrial case study. *Journal of Knowledge Management,* 7 (2), p. 34-45.

Kim, D.Y., Kumar, V., & Kumar, U. (2009). A Framework of Intellectual Capital Management Based on ISO 9001 Quality Management System: The Case Study of ISO 9001 Certified Public R&D Institutes. *Knowledge and Process Management,* 16 (4), p. 162-173.

King, W.R. (2009). *Knowledge Management and Organizational Learning.* Springer Dordrecht, Heidelberg, London, New York.

Kothari, C. R. (2009). *Research methodology: methods and techniques*. New Age International.

Levy, M., Hadar, H., Greenspan, S., & Hadar, E. (2009). Uncovering cultural perceptions and barriers during knowledge audit. *Journal of Knowledge Management,* 14 (1), p. 114-127.

Larsen, H. H., & Brewster, C. (2003). Line management responsibility for HRM: what is happening in Europe?. *Employee Relations*, 25 (3), p. 228-244.

Liebowitz, J., Rubenstein-Montano, B., McCaw, D., Buchwalter, J. & Browning, C. (2000). The Knowledge Audit. *Knowledge and Process Management,* 7 (1), p. 3-10.

Liefhebber, S., Radema, D., & van Arensbergen, C. (2010). Werkervaring in welzijn en jeugdhulpverlening.

Lim, L.K. & Dallimore, P. (2004). Intellectual capital: management attitudes in service industries. *Journal of Intellectual Capital,* 5 (1), p. 181-194.

Lin, H. F. (2007). Effects of extrinsic and intrinsic motivation on employee knowledge sharing intentions. *Journal of information science*, 33 (2), 135-149.

Liu, L., Li, J., & Lv, C. (2009). A Method for Enterprise Knowledge Map Construction Based on Social Classification. *Systems Research and Behavioral Research,* 26, p. 143-153.

Lloria, M.B. (2008). A review of the main approaches to knowledge management. *Knowledge Management Research & Practice,* 6, p. 77-89.

López-Nicolás, C., & Meroño-Cerdán, A.L. (2010). *A Model for Knowledge Management and Intellectual Capital Audits.* Knowledge Management Strategies for Business Development, 115.

Lusignan, S. de, Wells, S., Shaw., Rowlands, G., & Crilly, T. (2005). A knowledge audit of the managers of primary care organization: top priority is how to use routinely collected clinical data for quality improvement. *Medical Informatics and the Internet in Medicine,* 30 (1), p. 69-80.

Marr, B. (2008). *Impacting Future Value: How to Manage Your Intellectual Capital.* The Society of Management Accountants of Canada (CMA Canada), the American Institute of Certified Public Accountants, Inc. (AICPA) and The Chartered Institute of Management Accountants (CIMA).

Marr, B., Gupta, O., Pike, S., & Roos G. (2003). Intellectual capital and knowledge management effectiveness. *Management Decision,* 41 (8), p. 771-781.

Martín-de Castro, G., Delgado-Verde, M., López-Sáez, P., & Navas-López, J.E. (2011). Towards ' An Intellectual Capital-Based View of the Firm': Origins and Nature. *Journal of Business Ethics,*98, p. 649-662.

Martínez-Torres, M.R. (2006). A procedure to design a structural and measurement model of intellectual Capital: An exploratory study. *Information & Management,* 43, p. 617-626.

Meritum, (2002). *Guidelines for managing and reporting on intangibles (Intellectual capital report)*. Retrieved on October 25, from: http://www.pnbukh.com/files/pdf_filer/MERITUM_Guidelines.pdf.

Microsoft Office (n.d.). Wat is SharePoint, Retrieved on February 27, 2013 from http://office.microsoft.com/nl-nl/sharepoint-foundation-help/wat-is-sharepoint-HA010378184.aspx

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2008). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods*, 1(2), p. 13-22.

Nonaka, (1991). *The Knowledge Creating Company.* Harvard Business Review.

Nonnekes, H. (2005). *Kennismanagement bij TIO: een strategische benadering.* Master thesis: Technische Universiteit Eindhoven.

Nooteboom, B. (1996). *Towards a cognitive theory of the firm: Issues and a logic of change.* Proceedings AFEE conference, San Francisco.

Olivera, (2000). Memory systems in organizations: an empirical investigation of mechanisms for knowledge collection, storage and access. *Journal of Management Studies,* 37 (6), p. 811-832.

Peachey, T. & Hall, D. (2005). Knowledge Management and the Leading IS Journals: An Analysis of Trends and Gaps in Published Research. *Proceedings of the 38th Hawaii International Conference on System Sciences,* p. 1-10.

Perunovic, Z., Christoffersen, M., & Mefford, R. N. (2012). Deployment of vendor capabilities and competences throughout the outsourcing process. *International Journal of Operations & Production Management*, 32 (3), p. 351-374.

Petty, R. & Guthrie, J. (2000). Intellectual capital literature review: Measurement, reporting and management. *Journal of Intellectual Capital,* 1 (2), p. 155-176.

Punch, K. F. (2005). *Introduction to social research: Quantitative and qualitative approaches*. Sage Publications Limited.

Quińones, M.A., Ford, J.K. & Teachout, M.S. (1995). The relationship between work experience and job performance: a conceptual and meta-analytic review. *Personnel Psychology,* 48 (4), p. 887-910.

Quintas, P., Lefrere, P., & Jones, G. (1997). Knowledge Management: A Strategic Agenda. *Long Range Planning,* 30 (3), p. 385-391.

Roos, G., Pike, S., & Fernström (2005). *Managing Intellectual Capital in Practice.* Linacre House, Jordan Hill, Oxford.

Roos, J., Roos, G., Dragonetti, N.C., & Edvinsson, L. (1997) Intellectual Capital, Navigating the New Business Landscape. Macmillan Business, London.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students.* Fifth Edition. Essex: Pearson Education Limited.

Soliman, F., & Spooner, K. (2000). Strategies for implementing knowledge management: role of human resources management. *Journal of Knowledge Management*, 4 (4), p. 337-345.

Speel, P.H., Shadbolt, N., Vries, W. de, Dam. P.H., van & O'Hara, K. (1999). *Knowledge mapping for industrial*, 12th Workshop on Knowledge Acquisition Modeling and Management, Alberta, Canada, October.

Stewart, T.A. (1997). Intellectual Capital: The New Wealth of Organizations, Doubleday/Currency, New York, NY.

Stewart, T.A. (1998). Intellectual Capital. Retrieved on October 22, from: http://www.qfinance.com/human-and-intellectual-capital-best-practice/intellectual-capital?full

Tesluk, P. E., & Jacobs, R. R. (1998). Toward an integrated model of work experience. *Personnel Psychology*, 51 (2), p. 321-355.

Vail, E.F. (1999). Knowledge mapping: getting started with knowledge management. *Knowledge Management Review,* Issue 8, May/June.

Watthananon, J. & Mingkhwan, A. (2012). Optimizing Knowledge Management using Knowledge Map. *Procedia Engineering,* 32, p. 1169-1177.

Weggeman, M. (1997). *Kennismanagement: Inrichting en besturing van kennisintensieve organisaties.* Schiedam: Scriptum.

Wexler, M.N. (2001). The who, what and why of knowledge mapping. *Journal of Knowledge Management,* 5 (3), p. 249-263.

Wieringa, R. (2009). Design science as nested problem solving. *Proceedings of the 4th international conference on design science research in information systems and technology*. ACM

Youndt, M.A., Subramaniam, M., & Snell, S.A. (2004). Intellectual Capital Profiles: An Examination of Investments and Returns. *Journal of Management Studies,* 41 (2), p. 335-361.

Zhou, A.Z. & Fink, D. (2003). The intellectual capital web: A systematic linking of intellectual capital and knowledge management. *Journal of Intellectual Capital,* 4 (1), p. 34-48.

Appendix 1: Numbers inflow and outflow

	2010	2011	2012	average
Inflow technical personnel (numbers)	5	15	6	9
Total inflow (numbers)	9	31	18	19
Total number of employees	865	863	852	860
Inflow technical personnel (%)	0,58%	1,74%	0,70%	1,07%
Total inflow (%)	1,04%	3,59%	2,11%	2,25%

Inflow of employees, including technical personnel (2010-2012)

	2010	2011	2012	average
Total outflow (numbers)	46	41	27	38
Total numbers of employees	865	863	852	860
Total outflow (%)	5,3%	4,75%	3,17%	4,41%

Outflow of employees (2010-2012)

	2013	2014	2015	2016	2017	2018	Total
Outflow of employees	1	7	18	17	30	36	110

Forecast outflow (60 plus employees)

Appendix 2: Numbers inflow and outflow of departments

	2010	2011	2012
Production	5	18	7
Sales	2	8	8
R&D			1
Finance	1	1	1
Service	1	4	1
Total	**9**	**31**	**18**

Inflow of employees divided into departments (2010-2012)

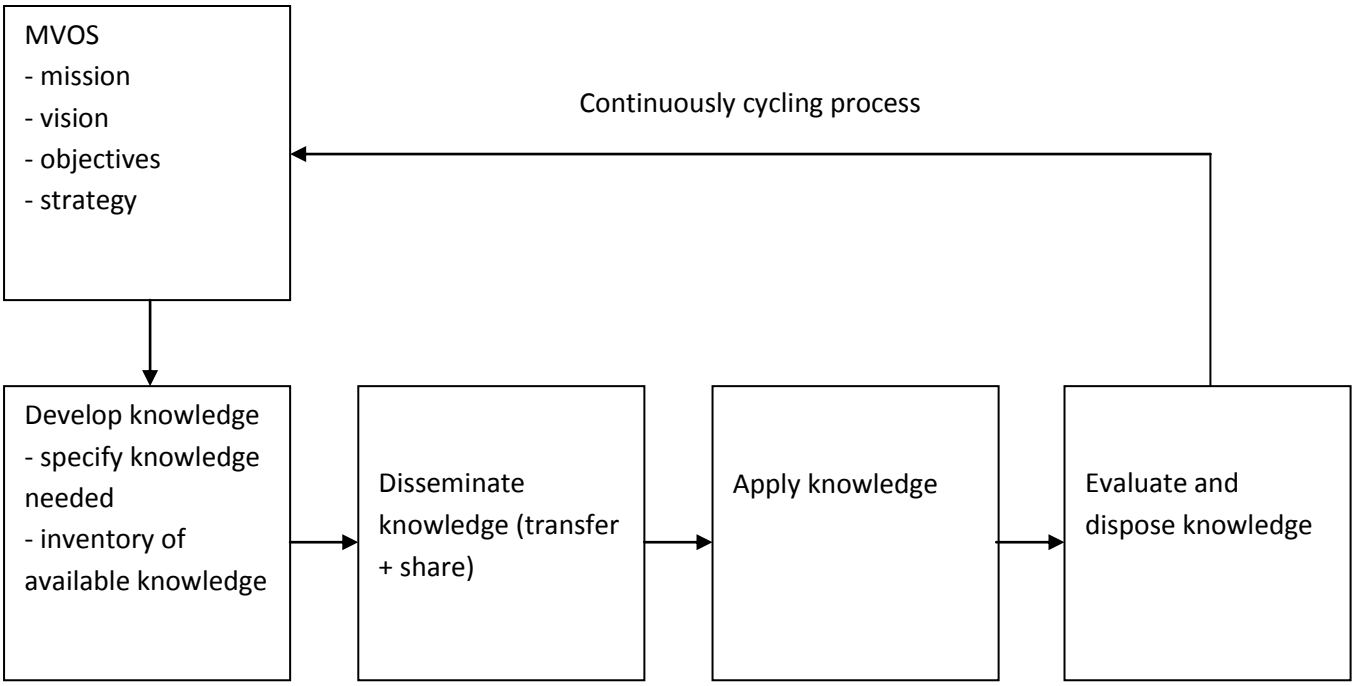
	2010	2011	2012
Production	25	18	19
Sales	11	9	7
R&D	5	5	1
Finance	1	2	
Service	3	7	
HR	1		
Total	**46**	**41**	**27**

Outflow of employees divided into departments (2010-2012)

	2013	2014	2015	2016	2017	2018
Production	1	5	14	12	16	21
Sales		1	1	3	9	10
R&D		1			2	3
Finance			2			
Service			1	2	2	
HR					1	1
IT						1
Total	**1**	**7**	**18**	**17**	**30**	**36**

Forecast outflow of employees divided into departments

Appendix 3: Knowledge value chain



Appendix 4: Questionnaires knowledge audit

Step 1 *Identify what knowledge currently exists in a targeted area*

1. List specifically the categories of knowledge you need to do your job
2. Which categories of knowledge listed in question 1 are currently available to you?

For each categories of knowledge you specified in question 1 . . .

3. How do you use this knowledge? Please list specific examples.
4. From how many sources can you obtain the knowledge? Which sources do you use? Why?
5. Besides yourself, who else might need this knowledge?
6. How often would you and others cited in question 5 use this knowledge?
7. Who are potential users of this knowledge who may not be getting the knowledge now?
8. What are the key processes that you use to obtain this knowledge?
9. How do you use this knowledge to produce a value added benefit to your organization?
10. What are the environmental/external influences impacting this knowledge?
11. What would help you identify, use or transform this knowledge more effectively?
12. Which parts of this knowledge do you consider to be (a) in excess/abundance, (b) sparse and (c) ancient/old/outlived its useful life?
13. How is knowledge currently being delivered? What would be a more effective method for delivering knowledge?
14. Who are the 'experts' in your organization housing the types of knowledge that you need?
15. In what form is the knowledge that you have gained from the experts?
16. What are the key documents and external resources that you use or would need to make your job easier?
17. What are the types of knowledge that you will need as a daily part of your job (a) in the short term (1-2 years) and (b) in the long term (3-5 years).

Step 2 *Identify what knowledge is missing in a targeted area*

1. What categories of knowledge do you need to do your job better?
2. What categories of knowledge do you reuse? Are there other instances where knowledge is not typically reused, but reuse would be helpful?

For each category of knowledge you specified in question 1 . . .

3. To what degree could you improve your level of performance by having access to all of the knowledge cited in question 1?
4. Who or what might serve as potential sources of this knowledge?
5. What types of question do you have to which you cannot find answers?

For each type of knowledge listed in question 5 . . .

6. Of the knowledge that is missing, which types are related to: (a) job performance, (b) competitive advantage of the organization, (c) possibly lead to future expansion of the organization or (d) simple administrative questions?
7. What department/people did you think would answer your question(s) but did not?
8. In what areas do you find yourself asking the same types of questions repeatedly?
9. Who has asked questions [that you are aware of] that have not been answered? In what department do they work? What level are they (i.e. job title)?
10. What people/departments have contacted you for information?

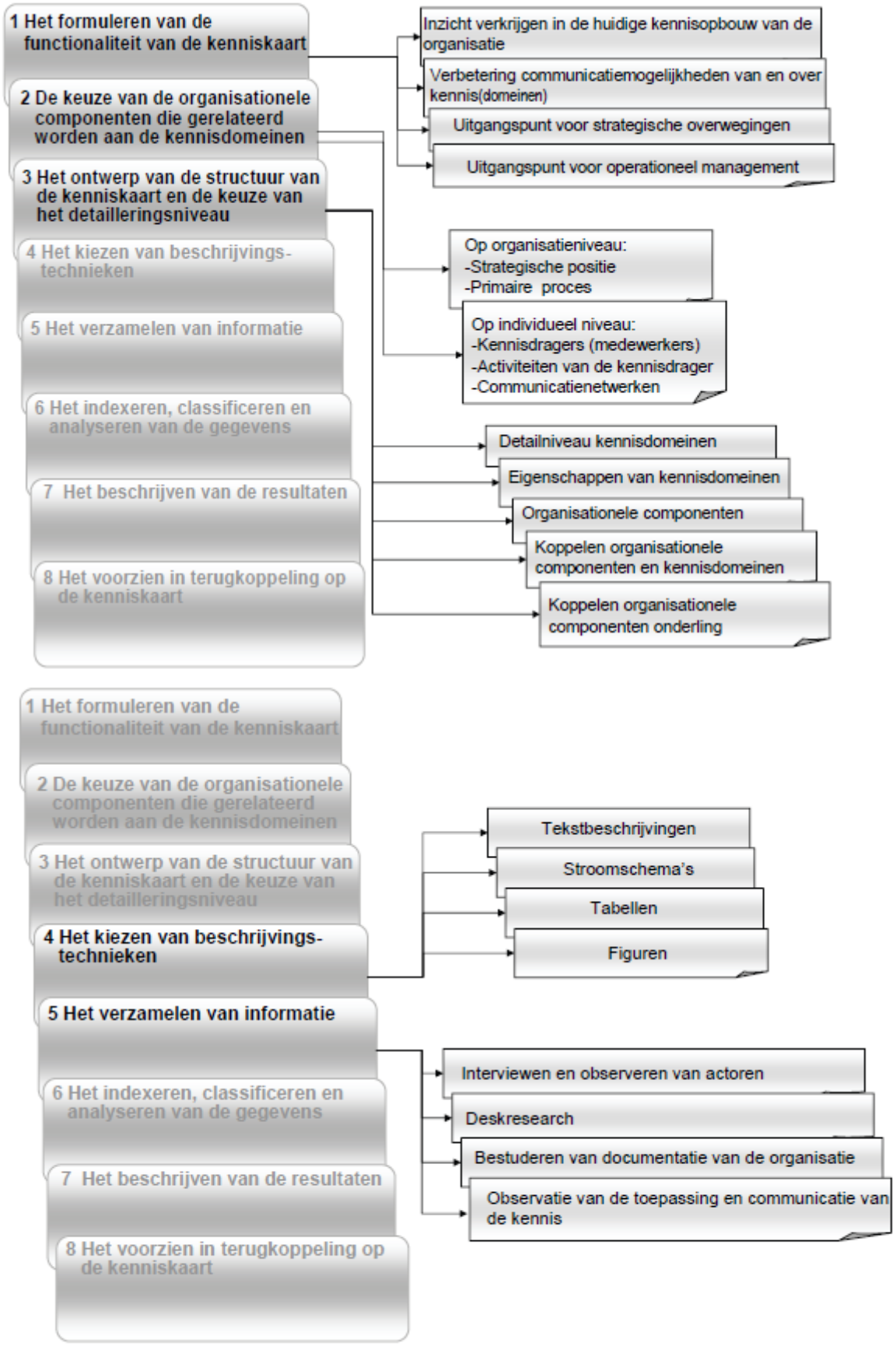
For each person/department listed in question 10 . . .

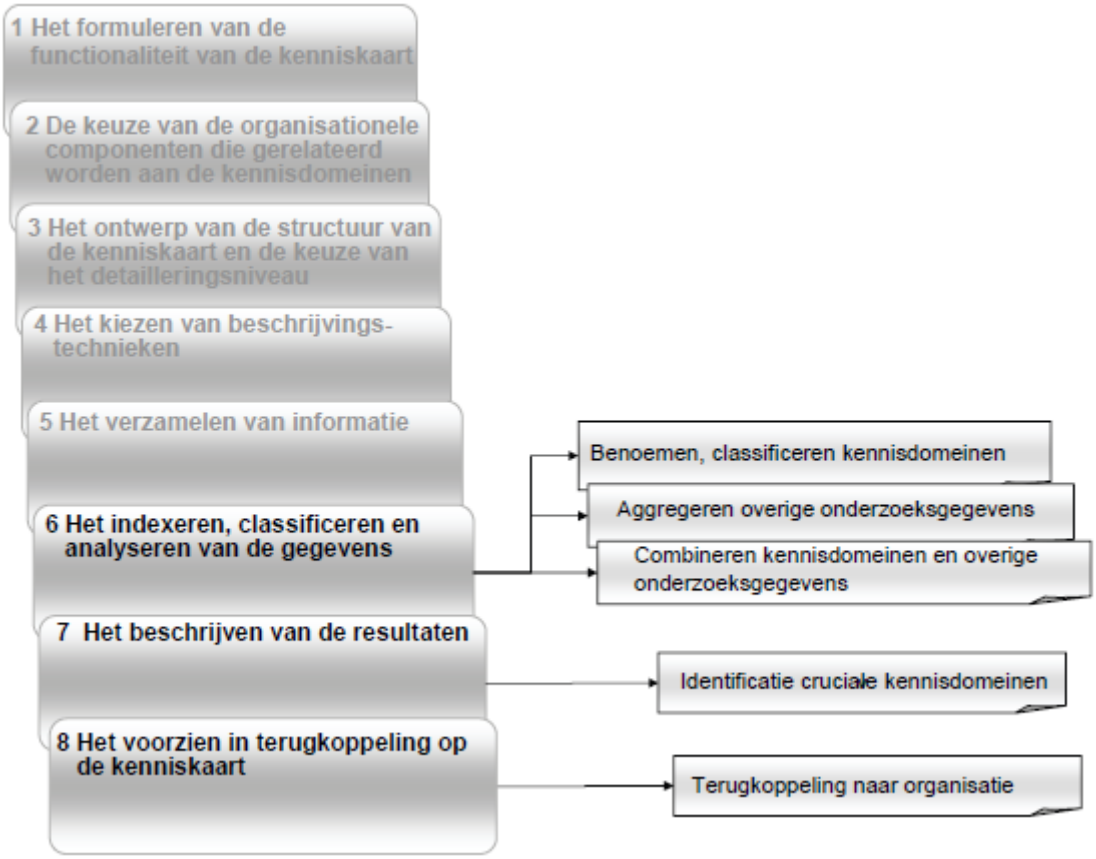
11. What level in the organization is each requester?
12. Is the requester a new employee (less than 1 year), a medium-term employee (1-3 years) or a long term employee (over 3 years)
13. Of the question that you have been asked by others in the organization, what knowledge was requested that you consider to be (a) essential for business performance, (b) essential for the company's competitive advantage, (c) important for leading innovations and new business areas in the future and (d) outdated and no longer useful for the business?
14. What mechanisms might be helpful for encouraging knowledge sharing and transfer in your organization?
15. Which aspects of your organization seem to provide barriers to effective knowledge management? (i.e. what constraints impede knowledge sharing and transfer?)
16. What are the main reasons that you could have made errors/mistakes on the job?

If your organization has considered outsourcing in the last 5 years . . .

17. In what areas was the outsourcing considered?
18. If outsourcing was rejected, why?
19. If outsourcing has taken place, why?
20. How much time do you spend looking for knowledge?

Appendix 5: 'Identick'




1 Het formuleren van de functionaliteit van de kenniskaart
2 De keuze van de organisationele componenten die gerelateerd worden aan de kennisdomeinen
3 Het ontwerp van de structuur van de kenniskaart en de keuze van het detailleringsniveau
4 Het kiezen van beschrijvings-technieken
5 Het verzamelen van informatie
6 Het indexeren, classificeren en analyseren van de gegevens
7 Het beschrijven van de resultaten
8 Het voorzien in terugkoppeling op de kenniskaart
Benoemen, classificeren kennisdomeinen
Aggregeren overige onderzoeksgegevens
Combineren kennisdomeinen en overige onderzoeksgegevens
Identificatie cruciale kennisdomeinen
Terugkoppeling naar organisatie

Appendix 6: Interview questions

1. Wat verstaat u onder kennismanagement?

2. Waarom is kennismanagement belangrijk voor Eaton?

3. Hoe is kennismanagement ingebed in de strategie van Eaton? Of is kennismanagement alleen ingebed in de HR afdeling van Eaton?

4. Wat heeft Eaton al gedaan op het gebied van kennismanagement?

5. Wat is de reden dat Eaton de kennis van werknemers nog niet heeft geïdentificeerd?

6. Welke problemen/veranderingen zijn er binnen Eaton die ervoor zorgen dat kennis in kaart gebracht moet worden?

7. Waaruit is de behoefte voor een tool om kennis in kaart te brengen uiteindelijk ontstaan?

8. Hoe ziet een tool er volgens u uit?

9. Wat zijn voor u belangrijke eisen waaraan de tool moet voldoen?

10. Denkt u dat een nieuwe tool de juiste oplossing is om kennis in kaart te brengen? Of zijn er wellicht andere manieren die ook toegepast kunnen worden? Zo ja, welke manieren zijn dat?

11. Heeft een tool om kennis in kaart te brengen kans van slagen? Beargumenteer uw antwoord.

Appendix 7: Knowledge areas

Application engineer voor laag- en middenspanningsystemen

1. Electrotechniek: selectiviteitberekeningen, laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek
2. Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen
3. Productportfolio van Eaton voor laag- en middenspanning
4. Sales Country Organisatie en de lokale markt: kennis over de organisatie, de plant en de afdelingen binnen Hengelo
5. BID Manager: output BID manager kunnen lezen, begrijpen en interpreteren en output kunnen vertalen naar de systemen
6. PC en programmatuur: Windows pakket, Autocad, Baan, diverse softwarepakketten beveiliging en Clink applicaties
7. Normen, standaarden, procedures en richtlijnen: toepasbaarheid IEC normen Eaton producten
8. Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken

Order manager

1. Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek
2. Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen
3.Organisatie en bedrijfsprocessen: planningsproces, orderproces, klachtenproces, supply chain proces, verkoopproces en zelfstandig beheer over het aan hem/haar toegewezen orderboek
4. Projectmanagement: interpreteren van internationale contracten, zelfstandig de planning maken en contract behandeling
5. PC en programmatuur: BID manager, beheer PCF en beheer Baan
6. IEC Normen en standaarden: weten dat er IEC normen en standaarden zijn
7. Incoterms en betalingsvoorwaarden: nationaal en internationaal, inkoopcondities van de klant begrijpen, het kunnen interpreteren en beoordelen van de inkoopvoorwaarden
8. Cost control orders
9. Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken

Order Processing Manager

1. Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek
2. Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen
3.Bedrijfsprocessen: orderproces, het kunnen interpreteren van klantcontracten en zelfstandig beheer over het aan hem/haar toegewezen orderboek
4. PC en programmatuur: BID manager, beheer PCF en beheer Baan
5. IEC Normen en standaarden: weten dat er IEC normen en standaarden zijn
6. Incoterms en betalingsvoorwaarden: nationaal en internationaal en inkoopcondities van de klant begrijpen
7. Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken

Appendix 8: Survey: Example Application Engineer

Instructie enquête

Beste werknemer,

Deze enquête wordt uitgevoerd voor mijn onderzoek binnen Eaton. Het richt zich op het in kaart brengen van kennis en ervaringen. Hieronder vindt u een matrix met de bijbehorende cruciale kennisgebieden. U dient, voor zover mogelijk, aan te geven het kennisniveau van de kennisgebieden, de moeilijkheid van kennisoverdracht, de mate van beheersing van opgedane ervaringen en de moeilijkheid om ervaringen over te dragen. Er zijn richtlijnen opgesteld die u kunnen helpen bij het invullen van de matrix. Deze kunt u vinden op de laatste pagina van de enquête.

Alvast bedankt voor uw medewerking!

Kennisgebieden Application Engineer	**Kennisniveau**					**Kennis-overdracht**			**Mate van de werkervaring**					**Ervarings-overdracht**		
	Geen kennis	Basiskennis	Toegepaste basiskennis	Gespecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: selectiviteitberekeningen, laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, schade applicatie en beveiligingstechniek																
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen																
Productportfolio van Eaton voor laag- en middenspanning																
Sales Country Organisatie en de lokale markt: kennis over de organisatie, de plant en de afdelingen binnen Hengelo																
BID Manager: output BID manager kunnen lezen, begrijpen en interpreteren en output kunnen vertalen naar de systemen																
PC en programmatuur: Windows pakket, Autocad, Baan, diverse softwarepakketten beveiliging en Clink applicaties																
Normen, standaarden, procedures en richtlijnen: toepasbaarheid IEC normen Eaton producten																
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken																

Handleiding kennis-ervaringsmatrix:

Kennis

Kennisniveau:
De kennisniveaus zijn onderverdeeld in vijf categorieën. Kruis de omschrijving aan in de matrix die voor u het meest van toepassing is.

- Geen kennis: u heeft geen/heel weinig kennis over het desbetreffende kennisgebied.
- Basiskennis: u heeft enige kennis over het desbetreffende kennisgebied, maar ontwikkeling is noodzakelijk.
- Toegepaste kennis: u beschikt over de basiskennis en kunt deze kennis gebruiken in verschillende situaties.
- Gespecialiseerde kennis: u beschikt over voldoende kennis van het kennisgebied en bent in staat om met deze kennis problemen op te lossen en/of verbeteringen aan te brengen.
- 'Expert' kennis: u heeft veel kennis over het desbetreffende kennisgebied en kunt anderen ondersteunen; u laat meer zien dan verwacht wordt.

Kennisoverdracht:
Kennisoverdracht is onderverdeeld in drie categorieën. Kruis de omschrijving aan waarvan u denkt dat deze van toepassing is op het desbetreffende kennisgebied.

- Makkelijk: het gaat om kennis die u kunt overdragen via geschreven of gesproken woorden, deze kennis is vaak opgeslagen in handboeken, protocollen, standaarden, e.d. (expliciete kennis).
- Gemiddeld: het gaat om kennis waarvan een deel is opgeslagen en een deel in uw hoofd zit (combinatie expliciete en impliciete kennis)
- Moeilijk: het gaat om kennis die in uw hoofd zit, wat moeilijker vast gelegd kan worden en waar het neerkomt op eigen ervaringen (impliciete kennis).

Werkervaring

Mate van werkervaring:
De mate van beheersing is onderverdeeld in vijf categorieën. Kruis de meest geschikte omschrijving aan voor de desbetreffende werkervaring.

- Beginner: u heeft weinig tot geen werkervaring over het desbetreffende kennisgebied.
- Gevorderd beginner: u heeft enige ervaring opgedaan over het desbetreffende kennisgebied, kunt aspecten of situaties herkennen die u eerder heeft meegemaakt en weet wat ermee te doen.
- Bekwame beroepskracht: u beheerst de taken van het kennisgebied goed, overziet situaties en ziet ze als geheel; de werksituatie is georganiseerd en u werkt steeds efficiënter en doelgerichter.
- Volleerde beroepskracht: u heeft veel ervaring over het kennisgebied, vindt het belangrijk om in het werk het verschil te maken, herkent complexe problemen en kan hierop anticiperen.
- Expert: u heeft essentiële ervaring opgedaan wat betreft het kennisgebied, kunt een meerwaarde creëren voor de omgeving en richt zich op zaken die er echt toe doen.

Ervaringsoverdracht:

Ervaringsoverdracht is onderverdeeld in drie categorieën. Kruis de omschrijving aan waarvan u denkt dat deze van toepassing is op het desbetreffende kennisgebied.

- Makkelijk: u beschikt over generieke (algemene) ervaringen, waarover veel andere werknemers op uw afdeling ook beschikken
- Gemiddeld: u beschikt grotendeels over generieke ervaringen en voor een deel over specifieke ervaringen, waarover ongeveer de helft van uw werknemers ook beschikt.
- Moeilijk: u beschikt over specifieke ervaringen, waarover weinig andere werknemers op uw afdeling ook beschikken.

Appendix 9: Results individual matrices

Kennisgebieden Application Engineer	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: selectiviteitberekeningen, laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek				X		X						X			X	
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen		X					X				X				X	
Productportfolio van Eaton voor laag- en middenspanning				X		X						X			X	
Sales Country Organisatie en de lokale markt: kennis over de organisatie, de plant en de afdelingen binnen Hengelo				X			X					X			X	
BID Manager: output BID manager kunnen lezen, begrijpen en interpreteren en output kunnen vertalen naar de systemen				X		X						X			X	
PC en programmatuur: Windows pakket, Autocad, Baan, diverse softwarepakketten beveiliging en Clink applicaties			X			X					X				X	
Normen, standaarden, procedures en richtlijnen: toepasbaarheid IEC normen Eaton producten				X		X						X			X	
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken		X				X					X				X	

Kennisgebieden Application Engineer	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: selectiviteitberekeningen, laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek				X		X						X			X	
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			X					X		X					X	
Productportfolio van Eaton voor laag- en middenspanning				X			X				X				X	
Sales Country Organisatie en de lokale markt: kennis over de organisatie, de plant en de afdelingen binnen Hengelo				X			X			X					X	
BID Manager: output BID manager kunnen lezen, begrijpen en interpreteren en output kunnen vertalen naar de systemen				X			X			X					X	
PC en programmatuur: Windows pakket, Autocad, Baan, diverse softwarepakketten beveiliging en Clink applicaties			X			X					X				X	
Normen, standaarden, procedures en richtlijnen: toepasbaarheid IEC normen Eaton producten				X		X					X				X	
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken			X				X				X				X	

Kennisgebieden Application Engineer	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: selectiviteitberekeningen, laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek				X			X				X			X		
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen		X						X		X						X
Productportfolio van Eaton voor laag- en middenspanning			X				X				X				X	
Sales Country Organisatie en de lokale markt: kennis over de organisatie, de plant en de afdelingen binnen Hengelo			X				X			X					X	
BID Manager: output BID manager kunnen lezen, begrijpen en interpreteren en output kunnen vertalen naar de systemen					X	X					X			X		
PC en programmatuur: Windows pakket, Autocad, Baan, diverse softwarepakketten beveiliging en Clink applicaties			X				X				X				X	
Normen, standaarden, procedures en richtlijnen: toepasbaarheid IEC normen Eaton producten		X						X		X						X
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken			X				X			X					X	

Kennisgebieden Application Engineer	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: selectiviteitberekeningen, laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek				X		X						X		X		
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			X				X				X				X	
Productportfolio van Eaton voor laag- en middenspanning				X		X						X		X		
Sales Country Organisatie en de lokale markt: kennis over de organisatie, de plant en de afdelingen binnen Hengelo				X		X						X		X		
BID Manager: output BID manager kunnen lezen, begrijpen en interpreteren en output kunnen vertalen naar de systemen				X		X						X		X		
PC en programmatuur: Windows pakket, Autocad, Baan, diverse softwarepakketten beveiliging en Clink applicaties				X		X						X			X	
Normen, standaarden, procedures en richtlijnen: toepasbaarheid IEC normen Eaton producten				X		X						X		X		
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken				X			X					X			X	

Kennisgebieden Application Engineer	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: selectiviteitberekeningen, laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek				X		X						X		X		
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			X				X				X				X	
Productportfolio van Eaton voor laag- en middenspanning				X		X						X		X		
Sales Country Organisatie en de lokale markt: kennis over de organisatie, de plant en de afdelingen binnen Hengelo				X		X						X		X		
BID Manager: output BID manager kunnen lezen, begrijpen en interpreteren en output kunnen vertalen naar de systemen			X			X					X				X	
PC en programmatuur: Windows pakket, Autocad, Baan, diverse softwarepakketten beveiliging en Clink applicaties				X		X						X			X	
Normen, standaarden, procedures en richtlijnen: toepasbaarheid IEC normen Eaton producten			X				X				X				X	
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken				X			X					X			X	

Kennisgebieden Application Engineer	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: selectiviteitberekeningen, laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek				X		X						X			X	
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen		X				X				X					X	
Productportfolio van Eaton voor laag- en middenspanning			X			X					X				X	
Sales Country Organisatie en de lokale markt: kennis over de organisatie, de plant en de afdelingen binnen Hengelo			X				X				X				X	
BID Manager: output BID manager kunnen lezen, begrijpen en interpreteren en output kunnen vertalen naar de systemen			X				X				X				X	
PC en programmatuur: Windows pakket, Autocad, Baan, diverse softwarepakketten beveiliging en Clink applicaties		X					X		X					X		
Normen, standaarden, procedures en richtlijnen: toepasbaarheid IEC normen Eaton producten				X		X					X				X	
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken		X				X				X				X		

Kennisgebieden Order Manager	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek				X				X					X			X
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			X				X				X				X	
Organisatie en bedrijfsprocessen: planningsproces, orderproces, klachtenproces, supply chain proces, verkoopproces en zelfstandig beheer over het aan hem/haar toegewezen orderboek				X				X				X			X	
Projectmanagement: interpreteren van internationale contracten, zelfstandig de planning maken en contract behandeling					X			X					X			X
PC en programmatuur: BID manager, beheer PCF en beheer Baan				X			X					X			X	
IEC normen en standaarden: weten dat er IEC normen en standaarden zijn				X			X					X			X	
Incoterms en betalingsvoorwaarden: nationaal en internationaal, inkoopcondities van de klant begrijpe, het kunnen interpreteren en beoordelen van inkoopvoorwaarden					X			X				X				X
Cost control orders				X				X				X				X
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken				X			X						X		X	

Kennisgebieden Order Manager	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek		X					X			X					X	
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen		X				X			X					X		
Organisatie en bedrijfsprocessen: planningsproces, orderproces, klachtenproces, supply chain proces, verkoopproces en zelfstandig beheer over het aan hem/haar toegewezen orderboek			X				X				X				X	
Projectmanagement: interpreteren van internationale contracten, zelfstandig de planning maken en contract behandeling			X			X				X					X	
PC en programmatuur: BID manager, beheer PCF en beheer Baan			X				X				X				X	
IEC normen en standaarden: weten dat er IEC normen en standaarden zijn		X				X				X				X		
Incoterms en betalingsvoorwaarden: nationaal en internationaal, inkoopcondities van de klant begrijpe, het kunnen interpreteren en beoordelen van inkoopvoorwaarden			X			X					X			X		
Cost control orders		X				X				X				X		
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken			X				X				X				X	

Kennisgebieden Order Manager	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek				X			X					X				X
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen		X				X				X				X		
Organisatie en bedrijfsprocessen: planningsproces, orderproces, klachtenproces, supply chain proces, verkoopproces en zelfstandig beheer over het aan hem/haar toegewezen orderboek				X			X					X			X	
Projectmanagement: interpreteren van internationale contracten, zelfstandig de planning maken en contract behandeling				X			X				X				X	
PC en programmatuur: BID manager, beheer PCF en beheer Baan				X			X				X				X	
IEC normen en standaarden: weten dat er IEC normen en standaarden zijn			X			X					X			X		
Incoterms en betalingsvoorwaarden: nationaal en internationaal, inkoopcondities van de klant begrijpe, het kunnen interpreteren en beoordelen van inkoopvoorwaarden			X				X				X				X	
Cost control orders			X			X					X			X		
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken			X			X					X			X		

Kennisgebieden Order Processing Manager	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek			X				X			X					X	
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			X				X				X			X		
Bedrijfsprocessen: orderproces, het kunnen interpreteren van klancontracten en zelfstandig beheer over het aan hem/haar toegewezen orderboek				X			X					X			X	
PC en programmatuur: BID manager, beheer PCF en beheer Baan				X			X					X				X
IEC normen en standaarden: weten dat er IEC normen en standaarden zijn		X				X					X				X	
Incoterms en betalingsvoorwaarden: nationaal en internationaal en inkoopcondities van de klant begrijpen			X				X				X				X	
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken					X		X						X		X	

Kennisgebieden Order Processing Manager	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek			X				X				X			X		
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			X				X			X					X	
Bedrijfsprocessen: orderproces, het kunnen interpreteren van klancontracten en zelfstandig beheer over het aan hem/haar toegewezen orderboek				X		X					X			X		
PC en programmatuur: BID manager, beheer PCF en beheer Baan				X		X					X			X		
IEC normen en standaarden: weten dat er IEC normen en standaarden zijn			X					X			X				X	
Incoterms en betalingsvoorwaarden: nationaal en internationaal en inkoopcondities van de klant begrijpen			X			X				X					X	
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken					X	X						X		X		

Kennisgebieden Order Processing Manager	Kennisniveau					Kennis-overdracht			Mate van de werkervaring					Ervarings-overdracht		
	Geen kennis	Basiskennis	Toegepaste kennis	Gepsecialiseerde kennis	'Expert' kennis	Makkelijk	Gemiddeld	Moeilijk	Beginner	Geavanceerde beginner	Bekwame beroepskracht	Volleerde beroepskracht	Expert	Makkelijk	Gemiddeld	Moeilijk
Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek			X					X		X					X	
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			X					X		X					X	
Bedrijfsprocessen: orderproces, het kunnen interpreteren van klancontracten en zelfstandig beheer over het aan hem/haar toegewezen orderboek				X		X					X					X
PC en programmatuur: BID manager, beheer PCF en beheer Baan					X	X							X		X	
IEC normen en standaarden: weten dat er IEC normen en standaarden zijn			X				X				X				X	
Incoterms en betalingsvoorwaarden: nationaal en internationaal en inkoopcondities van de klant begrijpen				X			X				X					X
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken				X		X					X					X

Appendix 10: Results group matrices

Application Engineer	**Kennisniveau**	**Mate van de werkervaring**	**Werknemer 1**		Werknemer 2		Werknemer **3**		Werknemer **4**		Werknemer 5		Werknemer **6**	
Electrotechniek: selectiviteitberekeningen, laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek			4	4	4	3	4	4	4	4	4	4	4	4
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			3	2	2	2	3	3	3	3	2	2	2	3
Productportfolio van Eaton voor laag- en middenspanning			4	3	3	3	4	4	4	4	3	3	4	4
Sales Country Organisatie en de lokale markt: kennis over de organisatie, de plant en de afdelingen binnen Hengelo			4	2	3	2	4	4	4	4	3	3	4	4
BID Manager: output BID manager kunnen lezen, begrijpen en interpreteren en output kunnen vertalen naar de systemen			3	2	5	3	4	4	3	3	4	4	4	4
PC en programmatuur: Windows pakket, Autocad, Baan, diverse softwarepakketten beveiliging en Clink applicaties			3	3	3	3	4	4	3	3	2	2	3	3
Normen, standaarden, procedures en richtlijnen: toepasbaarheid IEC normen Eaton producten			4	3	2	2	4	4	3	3	4	3	4	4
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken			3	3	3	2	4	4	4	4	3	3	2	3

Order Manager	**Kennisniveau**	**Mate van de werkervaring**	**Werknemer 1**		**Werknemer 2**		**Werknemer 3**	
Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek			4	4	2	2	4	5
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			2	2	2	1	3	3
Organisatie en bedrijfsprocessen: planningsproces, orderproces, klachtenproces, supply chain proces, verkoopproces en zelfstandig beheer over het aan hem/ haar toegewezen orderboek			4	4	3	3	4	4
Projectmanagement: interpreteren van internationale contracten, zelfstandig de planning maken en contract behandeling			4	3	3	2	5	5
PC en programmatuur: BID manager, beheer PCF en beheer Baan			4	3	3	3	4	4
IEC normen en standaarden: weten dat er IEC normen en standaarden zijn			3	3	2	2	4	4
Incoterms en betalingsvoorwaarden: nationaal en internationaal, inkoopcondities van de klant begrijpen, het kunnen interpreteren en beoordelen van de inkoopvoorwaarden			3	3	3	3	5	4
Cost control orders			3	3	2	2	4	4
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken			3	3	3	3	4	5

Order Processing Manager	**Kennisniveau**	**Mate van de werkervaring**	**Werkenemer1**		**Werknemer 2**		**Werknemer 3**	
Electrotechniek: laagspanningstechniek, middenspanningstechniek, automatisering, PLC technieken, Scada applicatie en beveiligingstechniek			3	2	3	3	3	2
Werktuigbouwkunde en materialen: materiaaleigenschappen en materiaaltoepassingen			3	2	3	2	3	3
Organisatie en bedrijfsprocessen: orderproces, het kunnen interpreteren van klancontracten en zelfstandig beheer over het aan hem/ haar toegewezen orderboek			4	3	4	3	4	4
PC en programmatuur: BID manager, beheer PCF en beheer Baan			5	5	4	3	4	4
IEC normen en standaarden: weten dat er IEC normen en standaarden zijn			3	3	3	3	2	3
Incoterms en betalingsvoorwaarden: nationaal en internationaal en inkoopcondities van de klant begrijpen			4	3	3	2	3	3
Nederlands en Engels goed kunnen spreken en schrijven, Duits kunnen spreken			4	3	5	4	5	5