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Successful Knowledge Management:

A practically applicable measurement method

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Abstract

The increasing dependency on knowledge within organizations asks for efficient and effective knowledge management (KM). In order to perform KM correctly, organizations need to know how to improve. This means finding out what they need to do to become better. In order to improve, organizations need to look at the current state of their KM. To do this, they need a way to measure how good they are performing in the field of KM and what aspects need to improve in order to increase KM performance. In this thesis, we focus on the development of a practically applicable model to measure KM success. We based our model on scientific literature on the factors that influence KM and the requirements of a KM measurement model and on the relative weight of these factors according to experts and end users. The proposed model can be used to measure the KM performance of an organization in the fields of "IT", "strategy and organization" and "employees and behavior" as well as the KM performance of an organization as a whole.

Contents

1 Introduction

There is more knowledge available than ever. Because of the rise of big data and the explosion of available data, companies hold more data than they can process. Companies want to base their decisions on knowledge, but a lot of knowledge is not used to its full potential. In order to use knowledge efficiently and effectively, it has to be managed. Krogh stated that "Knowledge management (KM) is a process of identifying, capturing, and leveraging the collective knowledge in an organization to help the organization compete." [57]. Hackbarth said that KM is used to increase informativeness and responsiveness [20]. Alavi and Leidner have identified the following primary goals of KM [4]:

1. improving decision making by supporting decisions with available information;

2. improving productivity by archiving best practices for future use;

3. reducing costs by reducing unneeded repetition of research and loss of valuable knowledge;

4. establishing consistent solutions to the reoccurring types of problems, by documenting used solutions and reoccurring problems.

There are three main factors that inhibit the efficient and effective management of knowledge in organizations:

1. Organizational culture does not reward sharing of insights. In many organizations, members feel that their futures, according to Krogh, "are dependent upon the expertise they generate and not on the extent to which they actually help others. In such situations, it is then expected that individuals will attempt to build up and defend their own knowledge" [57].

2. People dont have time to share their knowledge. Many organizations have such a high workload that employees, according to Glazer, "do not have time to make knowledge available, share it with others, teach and mentor others, use their expertise to innovate and find ways of working smarter" [18].

3. According to Riege, people are unaware that their knowledge can be useful for others [46].

Measuring the effectiveness of KM in an organization will help to identify these problems and show organizations where improvement is possible.
KM results in better decision making, faster response time, improved productivity, reduced costs and increased profit. According to Alavi and Leidner, KM also contributes to the creation of new business opportunities and a reduction of employee turnover [4]. Currently, there is a gap between KM research and KM practice. Arisha states that there is a lack of "simple and pragmatic solutions to current KM challenges" [1]. In order to know how to improve KM, the effectiveness has to be measured. For that purpose we need a practical measurement method. Existing KM frameworks are prescriptive, they provide outlines of what a firm needs instead of a way to measure what they do. Arisha also said that "a convincing KM performance measurement method has not yet been developed" [1], so a clear measurement technique is still needed.

In this bachelor thesis, supervised by Paul van Leeuwen en Tyron Offerman, we have developed a model that measures the effectiveness of KM in an organization. Based on literature on the subject of KM and existing measurement models we determined what factors influenced KM and researched the requirements for a new KM measurement model. A survey was used to determine the relative weights of the factors and fields in our model and the model was compared to the existing methods for measuring KM success. The complete process and the resulting model and conclusions are discussed in the the following chapters.

2 Background

In this background we will first focus on the broad subject of knowledge management in order to define it. After that we will elaborate on advantages that successful KM brings in the current organizational environment. In this section, we will advocate the importance of successful KM. Following this section, we will cover the factors that contribute to successful KM. These factors will be an essential part of our model. After that we will zoom in on the subject of measuring knowledge. In the chapter "Knowledge Measurement" we will explain the basis of knowledge measurement and cover several existing models for measuring knowledge.

2.1 The concept of knowledge management

We define knowledge management (KM) as "a process of identifying, capturing, and leveraging the collective knowledge in an organization to help the organization compete" [57]. We base this definition on the work of Krogh. Hackbarth described the increase in informativeness and responsiveness as the main purpose of KM [20]. We agree with his description.
According to literature, KM can be looked at from various perspectives. Fairchild spoke of an intellectual perspective, a social perspective, a structural perspective and a human perspective [17]. Liebowitz, among other things, also named structural capital and human capital as metrics to measure intellectual capital [31]. According to Tseng and Lee, organizations need to measure their performance in technological, human and financial resources [55] and Riege divided the barriers knowledge sharing into organizational barriers, technology barriers and individual barriers [46]. Gold divided "knowledge infrastructure capability" up into "technology", "structure" and "culture" [19].
KM research can, according to Arisha and Ragab, be classified in five different categories [1]. We adopted this classification as the structure of this section. We worked out these categories in 5 sub-chapters. In the sub-chapter on the ontology of knowledge, we explain 6 different definitions of knowledge. In the sub-chapter on knowledge management systems (KMS) we cover the three approaches to KMS. We will work out the most relevant IT tools in the sub-chapter on the role of information technology. In that sub-chapter, we will also cover the defining aspects of successful KMS implementations. In the sub-chapter on managerial and social issues, we cover the social and organizational problems that organizations face with regard to KM and in the sub-chapter on measurement, we will give an overview of the kinds of methods that can be used to measure KM success.

2.1.1 Ontology of Knowledge

According to Alavi and Leidner, knowledge can be defined in 6 ways: "data and information", "a state of mind", "an object", "a process", "access to information" and "a capability" [4]. We will shortly explain these 6 definitions:

1. Knowledge based on data and information: Data is facts such as numbers. When you process and model this data, you get information. Knowledge is the application of this information.

2. State of mind: The state of knowing something and understanding it.

3. Object: Knowledge is an object, for example a file, that can be stored and manipulated.

4. Process: Knowledge is a process in which expertise is applied.

5. Access to Information: Knowledge is knowing where to find information instead of the information itself.

6. Capability: Knowledge is about potentially influencing action.

All of these definitions have an implication for KM. "Knowledge based on data and Information" and "knowledge as a state of mind" focus on providing individuals with potentially useful information and facilitate the understanding of this information. When we define knowledge as an object, managing of knowledge stocks becomes the most important part of KM. If knowledge is defined as a process, KM focuses on knowledge flow and the process of handling knowledge. When knowledge is defined as access, KM focuses on the retrieval of and access to information. Seeing knowledge as a capability, leads KM to focus on organizational competences and strategy.

We used the work of Shannak [50] to map the implications of these definitions of knowledge on KM. When KM is identified as creating knowledge repositories, knowledge is treated separately from the people that use it. When KM is identified as "improving knowledge access and transfer", the focus lies on activities that provide access to knowledge or facilitate the transfer of knowledge between people. When KM is identified as enhancing knowledge environment, the emphasis lies on building awareness on the importance of knowledge sharing. When KM is identified as managing knowledge as an asset, the emphasis lies on valuating the knowledge in order to establish the value of intellectual capital.

In our research, knowledge is defined as a combination of the definitions described by Alavi and Leidner. Knowledge is partly based on data and information and can in some cases be stored and manipulated. However, we also see the capabilities of people and the access they have to certain information as important parts of knowledge. We see improving knowledge access and transfer as the basis of successful KM but, as Davenport said, "building awareness on the importance of knowledge sharing" [14] is also extremely important. Creating knowledge repositories is in our view, mostly a way to improve access and valuating the knowledge itself is of lesser importance.

2.1.2 Knowledge Management Systems

According to Massa, a knowledge management system (KMS) is a system which is built to support the implementation of KM in an organization [36]. Arisha stated that a KMS can be designed according to 3 approaches: codification, personalization and people finder [1]. We will explain these approaches:

1. Codification: Focuses on capturing, storing and retrieving knowledge. This approach uses a "people-to-documents strategy" that manages knowledge by building robust databases and rewards people who contribute knowledge [21].

2. Personalization: A "person-to-person strategy" that focuses on transferring knowledge by direct interaction. The emphasis lies on sharing knowledge and innovation and the systems function is to connect people [36].

3. People finder: This strategy does not save knowledge. It maps what knowledge everyone has so that people can see who holds knowledge within an organization [6].

These approaches could also be combined into a hybrid approach. This is an approach in which two or more of the, above mentioned, approaches are combined. For example, a system that combines personalization and people finder. Such a system will tell you who has the knowledge you need and provide a way to come into contact with this person. In our research we will, when we refer to KMS, assume a hybrid approach in which codification, personalization and people finder are combined.

2.1.3 Role of information Technology

KM is supported by various software tools. We will elaborate on the tools that are most relevant for this research.

Document and Content Management tools are used to store and share documents. These tools fit within the codification approach. Important aspects of this kind of tools are version control, indexing techniques, searching mechanisms and access.These tools have always been used for version control, storage, and retrieval of text documents. Nowadays, they can handle other file formats and use knowledge maps to categorize those files [10, 33].

Organizational Taxonomy tools are used to organize unstructured knowledge into a structured map. Most business decisions are based on unstructured information and most data is saved in an unstructured way. These tools build maps to organize this data. These tools also fit within the codification approach. Organizational taxonomy is a useful device for storing data and understanding variations within the organization[45, 33].

Collaboration Services are used to collaborate or communicate. They, for example, enable people to share access in order to work on the same document synchronously and asynchronously or watch the same presentation simultaneously. These tools are not used for storing and retrieving information. Instead, they are used to create and modify knowledge. These tools fit within the personalization approach [10, 33].

Data and Knowledge Discovery tools are used to generate new knowledge using existing data. Data mining tools and visualization tools are examples of knowledge discovery tools. These tools fit within the codification approach. [33, 41]

Expert Networks connect experts and enable them to share knowledge and help each other with problems. These tools fit within the people finder approach.[33, 49]

Competence management specifies the competence needs of an organization and identifies the competence gaps. The focus lies on the individual level. Possessing the skills needed to perform a job, job competence, is what is measured most. Competence management tools make profiles of employees that consist of their knowledge and their skills. These tools fit within the people finder approach.[33, 32]

Riege defines several technical factors that inhibit the sharing of knowledge via IT. Sharing knowledge trough IT is inhibited when IT systems and procedures do not comply with the way the organization works.This results in IT systems that are incompatible with processes. Another important problem in sharing knowledge via IT is the commitment to the system by people within the organization. If there is reluctance to use them, the IT systems will not generate the intended effect. Reasons for people to be reluctant about using an IT system are the failure of the system to meet unrealistic expectations, lack of the skills to use the system and not seeing the benefits of using the system. In order to prevent disappointment and ignorance to the system, it is important to inform the users on the advantages and shortcomings of a system. To prevent people from not using the system because they do not have the required skills, it is important to use IT systems that fit the requirements of the individuals that use them. Sufficient training and technical support are means to teach people the required skills [46, 56, 14]. In our model, these factors will be used to measure the influence IT has on KM success.

2.1.4 Managerial and Social Issues

According to Thomas et al. human and social factors must be taken into account when talking about KM [53]. An important problem in knowledge management is the fear of employees that contributing to a KMS or sharing their knowledge results in the loss of their unique value [44]. Other important reasons that inhibit people from the sharing of knowledge are not having enough time to share their knowledge [18], fear of publishing confidential information or something that violates company policy [43] and the lack of rewarding knowledge sharing. This results in a lack of knowledge sharing. Employees don't share their knowledge without expecting something in return. Knowledge sharing is primarily based on trade [5].

We will elaborate on the most important social inhibitors of sharing knowledge. People are unaware of the importance of sharing knowledge. Not only core employees must be acquainted with the importance of sharing knowledge. It is also important that other employees to share their knowledge with core personnel [46, 38, 11]. Another factor that inhibits the sharing of knowledge is the lack of direct interpersonal communication between the person who possesses the knowledge and the person that wants to receive the knowledge [46]. The fear of losing the unique value that knowledge brings to a company when their knowledge is shared is another important inhibitor.According to Krogh, in many organizations, employees feel that their careers "are dependent upon the expertise they generate and not on the extent to which they actually help others. In such situations, it is then expected that individuals will attempt to build up and defend their own knowledge" [57].

Besides social inhibitors, there also are operational inhibitors of sharing knowledge. It is important that an organization takes initiatives with the objective to develop and communicate a clear KM strategy. They need to make sure that everyone is informed about the advantages of knowledge sharing and be transparent about the consequences and rewards. Sufficient resources should be dedicated to KM and the IT infrastructure should not inhibit communication and knowledge sharing. Hierarchies should not be a restriction in communication. Competitive-

ness within and between business units inhibits efficient KM because it obstructs the openness that results in knowledge sharing [46].

Taking away the managerial and social inhibitors of knowledge sharing is, in our view, one of the most important parts of KM. These inhibitors will be used in our model to establish the level of KM in the fields of "strategy and organization" and "employees and behavior"

2.1.5 Knowledge Measurement

A reason to measure knowledge is to asses the value it has to the company. This value is measured to define the value of the intellectual capital of an organization. According to Steward, "The intellectual capital is the sum of knowledge, information, intellectual property and experience" that an organization could use to generate income. " [52].

There are internal and external drivers to measure the intellectual capital. An internal driver is the desire of managers to know what intellectual capital they have and where they can find it. [7] It can be used to discover hidden knowledge, the use of which can result in a increase in performance [16]. Measuring the value of knowledge can also help to evaluate the impact of KM and convince managers of the value of KM [31, 47]. The external driver to measure the value of knowledge is that Bontis states that " knowledge is an intangible asset" and that it needs to be included in a valuation. Knowledge measurement is extremely difficult, because knowledge is fluid and intangible [26]. According to Chen, the measurement of KM performance can be done in various different ways [13]: "qualitative analysis", "quantitative financial indicator analysis", "quantitative non-financial" indicator analysis", "internal performance analysis", "external performance analysis", "project oriented analysis" and "organizational oriented analysis" . Underneath, we will shortly explain these ways of analysis:

1. Qualitative analysis: Using surveys, interviews and the factors that contribute most to success.

2. Quantitative financial indicator analysis: Using metrics that are used to measure financial performance like internal rate of return, return on investment and Tobin's q.

3. Quantitative non-financial indicator analysis: Using "communities of practice", "individual context", "content" and "process knowledge assessment".

4. Internal performance analysis: Using, for example, balanced scorecards to measure performance.

5. External performance analysis: analyzing performance by means of comparing with other organizations.

6. Project oriented analysis: Aimed at learning form projects.

7. Organizational oriented analysis: aimed at the whole organization and its different layers and dimensions.

In our model, we will use a qualitative analysis and questionnaires to measure critical success indicators. Our model will also be suitable for external performance analysis using benchmarking.

Specific knowledge measurement methods will be covered in Section 2.4 "Knowledge measurement methods".

2.2 Added value of KM

Effective knowledge management can be of great help in the successful handling of knowledge. In this section we will elaborate on the benefits of successful knowledge management.

According to Jones, the hoarding of knowledge can do harm to a company. When knowledge is shared, it is used more effectively. Companies have to be able to convert the individual knowledge and experiences to group knowledge, so it won't be lost after an employee leaves the company. [25]

Kim states that in the current economy "employees are switching jobs several times" in their career [28]. Based on a large study, Parise states that 46% of executives expected to remain in their positions less than five years and a large multinational estimated that the expected loss as a result of the departure of one experienced marketing manager could be millions of dollars because of the knowledge that would be lost [42].

The shorter span of employment makes converting employee knowledge to corporate knowledge extremely important. One of the many benefits of KM is that it can be of help in converting employee knowledge to corporate knowledge. [24]

The systematic measuring of knowledge supports decisions about human capital [9]. Knowledge management systems have resulted in less time spent on proposals, time savings, better project management, increased employee participation, improving communication, improving the visibility of the opinions of plant staff, reducing the time it takes to solve problems, improving customer service and providing better accountability and measurement [3].

We believe, the sharing of knowledge to be a pivot point in KM. We expect that KM will have the greatest added value if it results in an increase of knowledge sharing. Enhancing storing and finding of knowledge is an integral part of that.

2.3 Success factors in KM

A literature review by Rogab and Arisha identified factors that contribute to KM success [1]. In this section, we will discuss these factors.

It is important to define KM and its benefits in order to get the organization on board. People won't contribute to KM unless they understand the added value. According to Rogab and Arisha, KM "should be linked to the business strategy" because the importance of knowledge and the usage of it is an important part of this strategy. For example, a company that wants to exploit a lot of data has other means for the usage of knowledge than a company that does not have any data to begin with.

Participation by and support of top management is important because they need to promote KM under other employees. Managers need to educate people on the importance of knowledge sharing and reward it. Knowledge sharing thrives in a culture of communication and teamwork. In order to work together efficiently you need to share knowledge and in order to share knowledge you need to communicate.

Organizations need to provide the right (IT) infrastructure to make the sharing of knowledge as easy as possible, but successful KM goes further than IT. Organizations need to adopt a holistic approach that supports KM. Apart from a good IT infrastructure there should be places and time for employees to physically come together and share knowledge.

It is important to appoint the right staff to KM projects and give them the right training. When people know how to handle knowledge as a result of that training, they will be far more effective in KM. The standardization and documentation of KM procedures and policies also help people to understand how they need to handle knowledge.

We see the sharing of knowledge, correct handling of staff and taking along employees as the most important aspects of successful KM. Among others, these aspects will be included in our model as factors that influence successful KM.

2.4 Knowledge measurement methods

In this section we will cover methods to measure intangible knowledge. The methods that we will discuss are 'balanced scorecards', 'intellectual capital' and 'concept mapping'. We will also cover a framework developed by Shanak. Other methods that are used to measure intangible knowledge, such as "Human resource accounting" (HRA) and "Economic value added" (EVA), are not discussed because they are only used to valuate the knowledge and not the way it is handled.

2.4.1 Balanced Scorecard (BSC)

The first method that we will discuss is the "Balanced Scorecard" (BSC) method. The rationale behind this method is that companies need a system that entails internal and external indicators.
According to Kaplan, the BSC "relies on four processes to bind short term activities to long term objectives: translating the vision, communicating and linking, business planning and feedback and learning" [27]. Underneath, we will shortly explain these processes:

1. Translating the vision: The scorecard is a tool that helps managers to agree on the metrics that need to be used for putting their visions in to operation;

2. Communicating and linking:The scorecard helps in making strategy a tool available for all levels of the organization.The high level scorecard can help to communicate strategic objectives and measures to lower level management where it can be translated into appropriate objectives and measures. Further down they can be tied to personal goals and individual performance measures;

3. Business planning: Balance scorecards can be used to link strategic planning and budgeting. The use of a balance scorecard forces the company to link budgetting to planning. It ensures that the budgets are in line with the strategic goals. The scorecard will be the driver to set milestones and measuring the progress;

4. Feedback and learning: The scorecard provides a reference point and a mechanism for strategic feedback. It enables reflection and learning.

Kaplan also described that the BSC is organised in four perspectives: "the customer perspective", "the financial perspective", "the internal business perspective" and "the learning and growth perspective" [27]. Underneath, we will shortly explain these perspectives:

1. The customer perspective: How do we want to appear to customers?

2. The financial perspective: How do we want to appear to our stakeholders?

3. The Internal business perspective: In what processes do we want to perform very well?

4. The learning and growth perspective: How can we change and improve?

These four perspectives are all linked to each other and based on the goal of achieving the vision.

Bontis states a couple of advantages and disadvantages of this method. The method is based on powerful logic. According to Bontis, "There is a clear correlation between indicators and financial performance" and the method is supported by consistent and well developed literature. Disadvantages are the fact that the model is static and the lack of ways of external comparison. [7]

Fairchild proposed a BSC based method to establish how KM is leveraged in organizations. She used four perspectives that could be related to the perspectives in balanced scorecards. Were BSC's use a financial perspective the KCO (Knowledge Centric Organization) method that she describes uses an 'intellectual' perspective. Instead of a customer perspective in BSC, KCO uses a 'social' perspective. Instead of a internal perspective KCO uses a 'structural' perspective and instead of a learning and growth perspective, she uses a 'human' perspective. She also proposed a second way to measure KM using BSC's. 'Employees' replace the financial perspective. The customer perspective remains intact. The internal perspective is replaced with 'processes' and the learning and growth perspective is replaced with 'technology'. [17]

She describes various generic ways to measure the perspectives in these methods.

According to Bontis, balanced Scorecards (BSC) are a way to "bind short term activities to long term objectives" using various perspectives. Fairchilds KCO method works in a similar way but it is aimed at establishing how KM is leveraged in an organization. It is not enough focused on the handling of knowledge. Also, this model cannot be used to measure the effect of certain activities to increase KM success. [17]

2.4.2 Intellectual Capital (IC)

The last method discussed by Bontis is the method of Intellectual Capital. The rationale behind this method is the fact that a substantial part of the value of a company is assessed based on intangible assets. These assets need to be monitored in the same manner as the tangible assets. [7]

According to Roos, Intellectual capital is a combination of "human capital" and "structural capital". Human capital consists of competence, attitude an intellectual agility. Structural capital consist of relationships, organization, renewal and development[48].

The IC indicators are chosen based on the long term strategy of the company. The IC measurement system is built on two types of indicators. The key success factors and the factors that create value.

When intellectual capital indicators are looked at individually, they still do not account for the overall situation at the organization. All factors need to get a weight en be consolidated into a single summary measure in order to say something about the overall situation.

Companies will have different indicators and weights because there are differences in their organizations. therefore, the state of the intellectual capital cannot be compared. What can be compared is the relative improvement of the IC index in various companies.

Advantages of this method are the fact that it is flexible and dynamic and the fact that partial external comparison is possible. A disadvantage of this method is the fact that external comparison is only partially possible.

In order to be an indication for the whole organization, all factors need to get a weight and be consolidated into a single summary measure. External comparison is hard and the IC index does only give an index. It does not state how good this score is. This method has aspects that could

be used in our model. We will identify key success factors and define their relative influence on KM success. Because our factors and weights will be the same for all organizations, the score in our model will be able to determine how "good" an organization performs in KM.

2.4.3 Gold's model for measuring organizational capabilities

In 2001, Gold et al. hypothesized a model to measure knowledge infrastructure capability using a technological perspective, a structural perspective and a cultural perspective [19]. This was, together with knowledge process capability, part of a model to measure organizational effectiveness. In the part of the model that measures knowledge infrastructure capability "Culture was seen as the most important factor (0.81). Technology (0.71) and structure (0.70) were seen as less important [19].

A survey with statements is used to determine whether factors that influence these field are in place. The agreement or disagreement with these factors and the relative weight of these factors make up the score of the fields. The measures are derived from scientific and practitioner literature on KM. The initial set was assessed with a q-sort technique. Items that were consistently classified wrongly were deleted from the set. [19]

2.4.4 Shanak's framework for measuring KM success

Shanaks research method provides a framework for a model to measure KM success.

Rifat O. Shannak researched "which performance indicators should be used when measuring performance of activities in knowledge management systems". He identified four broad types of knowledge management projects. Those four types were "creating knowledge Repositories", "Improving knowledge access and transfer", "enhancing the knowledge environment" and "managing knowledge as an asset". [50]

According to Tseng and Lee [55] organizations need to measure their performance in technological-, human- and financial resources. Where financial resources are tangible and relatively easy to measure, technological and human resources are intangible and therefore harder to measure. In order to measure the intangible KM success, there is a need to develop performance indicators. According to Shanak's research, "there are four ways to express performance indicators" [50]:

1. The amount of times that an event occurs;

2. A ratio of the amount of times that an event occurs and the amount of times it could have occurred;

3. A percentage;

4. A Boolean variable (true or false, yes or no, etc.).

Performance indicators need to be relevant with regard to the company goals and they need to be provisional.

Performance indicators can be qualitative or quantitative. Qualitative indicators could, for example, be indicators of culture, believes and attitudes. Quantitative indicators can, for example, indicate participation in a certain project.

The method discussed by Shanak measures the success of certain KM initiatives in a company. The problem with this method is that it cannot be modelled to fit every organization. Different events occur in different organization and therefore we cannot build a model to measure how good companies perform with regard to KM based on his method.

2.4.5 Concept mapping experiment

M.R. Matinez-Torres performed an experiment [35], in which he used concept mapping and structural equation modelling in order to model "the use of intellectual capital in a knowledge-based organization". He developed a model that connects the various parts of intellectual capital to understand the "intellectual wealth of a learning organization".

According to Trochim, concept mapping is a way of "structured conceptualization" that is generally used to develop conceptual frameworks to be used in evaluations or plans [54]. In this experiment, it was used to "identify the intangible assets that make up the intellectual capital". This method consists of six stages [54]:

1. Selection of members of a group of experts and establishing the focus and main problem.

2. Brainstorming the the factors that influence the main problem.

3. Classifying these factors by members of the group.

4. The data is analyzed and clustered in cluster maps.

5. The cluster maps are interpreted.

6. The cluster maps are used for planning and controlling

Matinez-Torres discussed a method, using concept mapping, to model "the use of intellectual capital in a knowledge based organization" [35]. The model helps to understand the value of intellectual capital in an organization. The concept mapping could be a good way to determine what factors influence KM. We used literature instead of brainstorming to find the factors and cluster them. A survey and interviews were used to validate our factors and clusters (fields).

2.5 Problem statement

We define the success of KM based on its effectiveness. Challenges in KM include the increasing amount of available data and the lack of a clear applicable measurement technique. In order to know how to handle all this data in a more successful manner, there is a need for a simple, pragmatic and understandable way to measure the success of KM and identify points of improvement. This research will result in a new KM measurement model. This model will help in making the intangible data about KM measurable in order to reveal possible points of improvement.

2.6 Research questions

In order to know how to increase KM success, there is a need to build a practical model to measure the and the success of KM. therefore we need to identify the factors that contribute to efficient KM in an organizational environment and establish to what extend they weigh into KM success. The research question is as follows:

"How can we asses the effectiveness of knowledge management in an organizational environment, using a practical measurement method?"

In order to answer this question the following sub questions need to be answered:

1. What are the factors that impact the effectiveness of KM?

2. How strongly do these factors relatively weigh in to the success of KM?

3. What are the requirements for a method that measures KM success?

2.7 Scope

This research is focused on measuring the effectiveness of knowledge management. Besides discovering the reasons for ineffective knowledge management and best practices in the field of KM, our research will focus on ways of measuring their impact on the performance of an organization. We will use the views and experiences of experts and end users to develop the basis for our model.

2.8 Limitations

We will not focus on the monetary value of the knowledge in an organization. The effectiveness of how knowledge is managed can play a part in how it generates value, but there are many other things that contribute to the value of knowledge. We will focus on the management of knowledge and create a way to measure the level of KM success.

2.9 Relevance

In this section, we will cover the relevance of our research in both the academic field and in practice.

2.9.1 Academic relevance

DeLone and McLean state that individual measures from the existing success categories should be combined into a comprehensive measurement instrument. Existing KM frameworks are prescriptive. They provide outlines of what a firm needs instead of a way to measure what they do. According to Arisha and Ragab, "A convincing KM performance measurement method has yet to be developed." [1], so a new clear measurement method has significant added value. According to Arisha et al. KM research needs to provide a pragmatic solution for organizational KM problems. They also state that there is a need for new improved measurement models "Research should aim to produce a framework targeted at acquiring widespread acceptance and becoming a global standard for KM, in the same manner the Balanced Scorecard is

for Performance Management". They also believe that this model should be straightforward enough to be understood by end users that need to apply them and won't always be KM experts" [1].

According to Ahmed, researchers should be diligent in developing measurement systems because inappropriate measurement can have a strong effect on KM. Ahmed also states that an effective KM measurement system should go further than traditional (financial) measures. He believes that non financial measures are more relevant in tracking progress [2].

Carrillo et al, see evaluation of KM as one of its major problems. "Performance measurement models provide a basis for developing a structured approach to KM" [12] and Bontis et al. underline that it is difficult to measure knowledge using traditional measures and state that there is no universally best tool to measure KM [8].

2.9.2 Practical relevance

Knowledge that is not shared, can go to waste when people leave an organization. Nolan researched this and found that almost 50% of the researched companies "suffered significant damage as a result of losing key staff". Almost all participating companies stated that "knowledge of the best practice in a specific area of operations had been lost when an employee left the company" [23].

Research has to be aimed at KM practice because of a gap between KM theory and KM practice. Because of the current lack of practical relevance in KM research, practitioners contribute less to scientific research in this field and therefore existing models don't fit their needs and aren't used. According to Arisha, this trend can be reversed "by more engagement with industry" by the KM research domain. It is important to create "simple and pragmatic solutions to current KM challenges" like measurement [1]. Arisha also states that the gap between KM theory and KM practice can be partly closed by a practically usable scientific model that can be used by practitioners to measure the success of their KM strategy [1].

Better KM can reduce dependency on certain individuals and therefore create a more stable knowledge base within the organization. Measuring the effectiveness of KM helps to find ways to improve the practice of KM. Therefore this research has a practical relevance for all companies that have the ambition to improve their KM strategy.

3 Methodology

In order to answer the research question we used a design research approach described by Hevner [22] to design the measurement framework. Design research is aimed at designing an artifact, in this case the measurement model, based on the relevant environment, and a scientific knowledge base. The scientific knowledge base consists of papers on knowledge management and knowledge measurement.

The process can be seen as 3 cycles that are shown in Figure 1. The pivotal cycle (the design cycle) is the one in which the measurement model is build and evaluated. At the right hand side, it is linked to the Rigor cycle in which the scientific foundations for the model can be found. This cycle entails scientific theories and methods, experience and expertise. At the left hand side you find the relevance cycle. This cycle is the base for field testing and gathering requirements among experts [22].
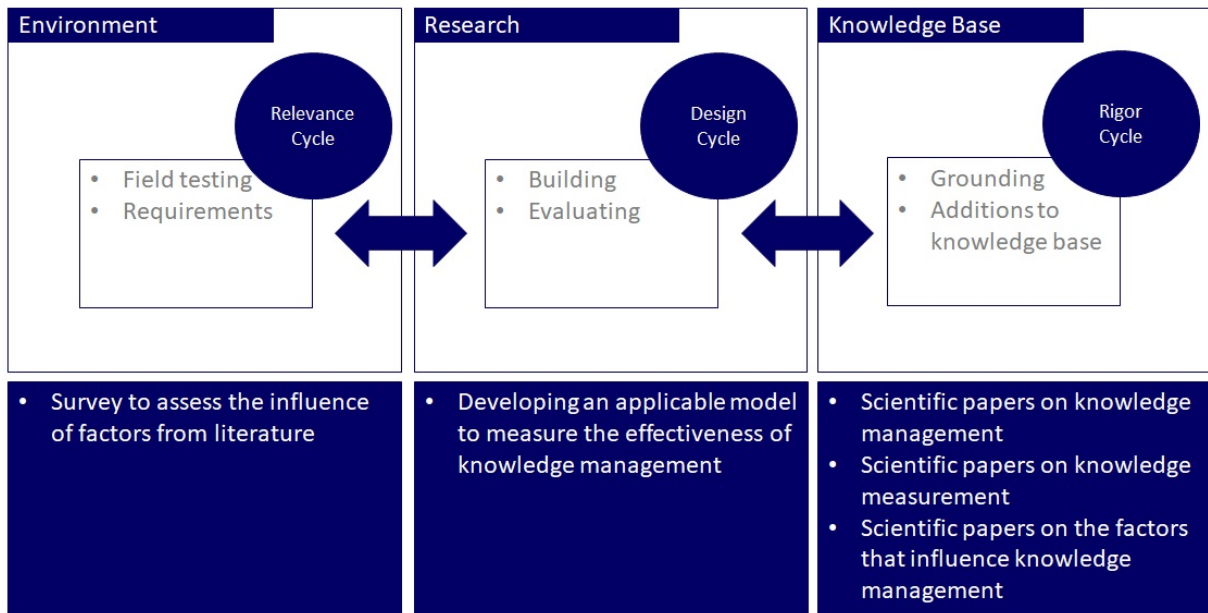
Figure 1: design process [22]

First, in order to get a broad view on relevant factors in KM, we searched for inhibitors and success factors that influence KM in research papers on the topics of KM systems and KM best practices. Based on those sources we wrote the first part of the background, the part on KM.

After that, we have identified existing measurement methods for intangible assets from literature, and researched the requirements for a new measurement method in literature on the subject of KM. In our approach, this research fits in the Rigor Cycle.

Then, we researched existing models for knowledge measurement and literature reviews on the subject of KM in order to establish the main factors that contribute to success and failure. This also fits in the Rigor Cycle.

Based on the background, we have identified factors that play a role in the success of KM. In order to establish their (relative) influence on the success of KM, we sent out a survey (see Appendix 8.1) for which, we were mainly interested in the views of consultants and managers in the IT- and Strategy department. These people are relevant for our research because they have to set out, implement, and work according to the KM strategy. Arisha states that "Managers contribution to KM framework development is crucial to ensure a degree of applicability and to avoid the development of purely theoretical models that would only be of interest to academics." [1]. This part of our research fits into the Relevance Cycle. The people in the content management group of Vattenfall make up half of our survey respondents. As an utility company, Vattenfall is an example of a company that has experienced a lot of changes in recent history. Internationalization has lead to the acquisition of companies that managed knowledge in different ways. Activities in various countries and cultures make generic KM a great challenge. The rest of our respondents were found via a targeted post on LinkedIn. These people were selected based on their practical experience with KM.

The most important goal of our survey was to establish the influence of our three main fields on KM and to establish the influence of factors within these fields. In order to quantify the relative influence of the success factors and inhibitors of successful KM, we used closed questions in which the participants had to rate the importance of those factors on a scale from 1 to 10. They also had to rate the influence of different aspects of KM (Social, IT and Strategy) on

14

other factors and the influence of those three aspects as a whole.

We have also used our survey to establish to what extend our three main fields influence the factors on other fields. Respondents were asked to value factors based on the influence that a field, for example employees and behavior, has on the factors in the field of strategy and organization.

Based on the survey results we developed a model to measure KM success that included the direct influence of various factors on successful knowledge management as well as the influence that fields have on each other. The development of our model fits in the Design Cycle.

4 Results

In this chapter we present our results. In the first subsection, we will present the survey results on which we based the weights of factors and fields in our measurement model. In the second subsection, we will present the proposed model to measure KM success.

4.1 Survey results

In this section, we will cover the results of our survey.

4.1.1 Respondents

Nineteen people took part in our survey. We found our respondents via an internal mail in the content management group of Vattenfall and via posts on LinkedIn. The group consisted, among others, of four content managers, three project managers and two quality coordinators (see Table 1). We asked all respondents to value their experience level with regard to KM (see Table 2). Ten respondents had experience with the practical application of KM, six had applied theory, one was only fundamentally aware and two had limited experience with the subject.

Job title	respondents
Content manager	4
Project manager	3
Quality coordinator	2
(Agile) coach	2
Strategy manager	1
Interim manager	1
HR officer	1
Director	1
Meeting & meeting process coordinator	1
Internal financial control officer	1
Responsible arhivist regarding analogue archives	1
Unknown	1
total	**19**

Table 1: Job titles of the survey respondents

Experience level	respondents
Fundamental Awareness (basic knowledge)	1
Novice (limited experience)	2
Intermediate (practical application)	10
Advanced (applied theory)	6
total	**19**

Table 2: Experience levels of the survey respondents

4.1.2 The influence of our three main fields on successful knowledge management

We have singled out 3 fields of factors that influence KM. In table 3 we show how the respondents scored the fields based on the influence they have on KM success. In the rows, we display the amount of respondents that gave the field the score that is displayed in the first row.

Table 3 shows that most fields are rated above 5 by our respondents. The field of "employees and behavior" gets a maximum score (10) from 6/19 respondents and 16 respondents rate this field 8 or higher. The field of "strategy and organization" gets rated 8 or higher by 13 respondents and 2 of them give the maximum score. 8 respondents rate the influence of "IT" at 8 and none of them rate it 9 or 10. None of our respondents rate "strategy and organization" and "employees and behavior" below 3 and one respondent rates "IT" at 0. This is the only score in this field below 3.

Field	0	1	2	3	4	5	6	7	8	9	10
Strategy and organization	0	0	0	0	1	0	1	4	6	5	2
Employees and behavior	0	0	0	1	1	1	0	0	6	4	6
IT	1	0	0	0	1	1	4	4	8	0	0

Table 3: The number of respondents that selected a score per field

4.1.3 Cross field influence

Respondents were asked to value fields based on the influence they have on the factors in other fields. For example, the influence "employees and behavior" has on the factors in the field of "strategy and organization". We aggregated those factors in every field to keep the tables orderly. A more extensive overview of the cross field influence according to our respondents can be found in Appendix 8.2.

Influence by the field of "IT" on the other two fields
The values in table 4 represent the sum of the times that factors in the field were ranked corresponding to the rating in the first row. For example, the 6 factors in the field of "strategy and organization" combined received 14 scores of 0. The scores that represent the influence of IT on factors in the field of "strategy and organization" are spread from 0 to 10. However, most scores fall between 6 and 8 and there is a peak of 20 at a score of 7. For the influence of "IT" on the field of "employees and behavior" the most chosen score was 5. The combined factors received 21 scores of 5. Most scores fall between 5 and 8.

Field	0	1	2	3	4	5	6	7	8	9	10
Strategy and organization	14	0	4	9	8	11	14	20	19	11	4
Employees and behavior	6	4	8	7	11	21	14	13	17	7	6

Table 4: The number of respondents that selected a score to indicate the influence of the field of "IT" on other fields

Influence by the field of "employees and behavior" on the other two fields
In table 5, we display the influence of the field of "employees and behavior" on the other two fields in the same way as the influence of "IT". The scores in this table are also spread from 1 to 10. The influence of "employees and behavior" on factors the field of "strategy and organization" was scored at 10, 22 times and there is a peak between 7 and 10. In the row that displays the influence of "employees and behavior" on "IT", factors were most often rated at 6 and 8 (both 17 times) followed by 5 and 10 (both 14 times). Factors in both fields weren't rated under 4 a lot and none of our respondents rated the influence a factor in the field of "strategy and organization" at 0.

Field	0	1	2	3	4	5	6	7	8	9	10
Strategy and organization	0	2	3	6	8	10	11	18	21	13	22
IT	4	3	8	10	7	14	17	11	17	9	14

Table 5: The number of respondents that selected a score to indicate the influence of the field of "employees and behavior" on other fields

Influence by the field of "strategy and organization" on the other two fields
We display the influence of the field of "employees and behavior" on the other fields in the same way a as we represented the influence of the other two fields. The scores that represent the influence of "strategy and organization" on the other two fields are distributed between 0 and 10. For the influence of "strategy and organization" on the field of "employees and behavior, none of our respondents scored a factor lower than 2. The score of 7 (28 times) and 8 (26 times) were most often used and the peak lies between 7 and 9. The influence of "strategy and organization" on factors in the field of "IT" was most often scored at 8 (29 times). The peak lies between 8 and 10.

Field	0	1	2	3	4	5	6	7	8	9	10
Employees and behavior	0	0	3	2	5	10	10	28	26	16	14
IT	2	2	6	3	5	5	9	14	29	22	17

Table 6: The number of respondents that selected a score to indicate the influence of the field of "strategy and organization" on other fields

4.1.4 The influence factors within the field of "strategy and organization"

In the field of "strategy and organization", we have singled out 6 factors that influence KM success. In table 7, we show how the respondents scored the factors based on the influence they have on KM success. The table shows the amount of respondents that gave the factor the score that is displayed in the first row.

Table 7 shows that the majority of our respondents rate our factors above 6. One factor, "An organizational culture that supports sharing of new knowledge and the usage of existing knowledge.", gets the maximal score (10) from 6/19 respondents. Three respondents score this factor lower than 8. The scores of "The existence of a clear KM strategy." and "Retainment of experienced staff" are more evenly distributed but the higher scored tend to prevail. "The existence of a clear KM strategy." is the only factor that gets a score of 0 (meaning no positive influence) by one of the respondents.

Factor	0	1	2	3	4	5	6	7	8	9	10
The existence of a clear KM strategy.	1	0	1	0	2	2	1	5	3	1	3
An organizational culture that supports sharing of new knowledge and the usage of existing knowledge.	0	0	0	1	0	1	0	1	4	6	6
Sufficient facilities within the company to come together and share knowledge.	0	0	0	1	1	1	1	2	5	3	5
Cooperation between business units.	0	0	1	1	1	0	0	7	3	1	5
Retainment of experienced staff.	0	0	1	0	1	1	3	4	3	3	3
Availability of existing knowledge.	0	0	1	0	0	0	5	1	5	2	5

Table 7: The number of respondents that selected a score to indicate the influence of factors within the field of "strategy and organization"

4.1.5 The influence factors within the field of "employees and behavior"

We also asked our respondents to rate the factors in the field of "employees and behavior" on a 1-10 scale. In table 8, we show how the respondents scored the factors in the field of "employees and behavior" based on the influence they have on KM success. The table shows the amount of respondents that gave the factor the score that is displayed in the first row.

Most scores that were given are in the range 6-10. "Motivation and commitment of employees towards the KM strategy." and "Usage of the available tools to save and share knowledge" were the only factors that were seen as 'not influential' by one our our respondents. "Sharing of knowledge among employees" and "Sufficient understanding among employees on how to handle knowledge" got the highest rating from 5 respondents.

Factor	0	1	2	3	4	5	6	7	8	9	10
Motivation and commitment of employees towards the KM strategy.	1	0	0	1	1	0	2	6	3	1	4
Sharing of knowledge among employees.	0	0	0	0	1	1	1	1	7	3	5
Cooperation of employees toward a common goal.	0	0	0	1	1	0	4	2	4	3	4
Sufficient documentation of research and projects.	0	0	0	0	1	2	4	6	4	1	1
Sufficient understanding among employees on how to handle knowledge.	0	0	0	0	1	1	1	5	4	2	5
Usage of the available tools to save and share knowledge.	1	0	1	0	0	1	0	8	5	1	2

Table 8: The number of respondents that selected a score to indicate the influence of factors within the field of "employees and behavior"

4.1.6 The influence factors within the field of "IT"

Just like for the other fields, we asked our respondents to rate the factors in the field of "IT". In table 9, we show how the respondents scored the factors based on the influence they have on KM success. The table shows the amount of respondents that gave the factor the score that is displayed in the first row.

The influence scores in the field of "IT" are mostly above 5. All factors get a 10 from at least two respondents. "Technical solutions that are in line with the needs of the organization and compatible with existing processes" received the most scores of 8 or higher (14/19). "Sufficient technical support" received 6 scores of 8 or higher.

Factor	0	1	2	3	4	5	6	7	8	9	10
Sufficient training of users to use content sharing systems.	1	0	0	1	2	0	3	1	7	2	2
Clarity among all users on what systems are supposed to be used.	0	0	1	0	2	0	1	3	5	4	3
Technical solutions that are in line with the needs of the organisation and compatible with existing processes.	0	0	1	0	0	2	1	1	7	3	4
Usage of the same systems by all employees to save and share knowledge.	1	1	0	0	1	1	5	2	2	3	3
Content sharing systems that are easily available.	1	1	0	0	1	0	4	0	5	4	3
Sufficient technical support.	1	0	0	0	2	1	3	6	4	0	2

Table 9: The number of respondents that selected a score to indicate the influence of factors within the field of "IT"

4.2 The proposed knowledge management measurement model

In this section, we will cover the various steps in our knowledge management measurement model.

4.2.1 Input

The survey in Appendix 8.3 has to be conducted under the employees of an organization in order to generate the input for our model. The employees will have to rate the 18 factors that make up our 3 fields on a 1-10 scale based on the extend to which they agree that they correspond with the situation at their organization.

4.2.2 Calculating KM success

We are proposing a model that is built up out of four layers (see Figure 7). The first layer consists of the factors that influence KM per field. They are linked via weighted arcs to the second layer were the preliminary field score is calculated. In the third layer, the preliminary field scores are adjusted for the influence of other fields. The adjusted field scores in the third layer are used to calculate a total score (fourth layer) that is based on the relative weights of these fields. These layers will be covered more extensively in the following sections.
Individual measures (the factors) from the existing success categories (the fields) are combined into a comprehensive measurement model. This is one of the requirements according to DeLone and McLean [15] on the subject of KM. We did not include the direct influence of other fields on factors within a field because that would have made the model far less simple, whilst there is a need for an understandable and practically applicable model. We also believe that factoring in this influence on a cross-field level has a similar result in calculating the KM performance score.

4.2.3 Output

The output of the model will consist of scores that rate the performance of an organization with regard to KM on three different levels. The score is calculated at a factor level in the first layer of the model. In the second layer, the performance in our three main fields ("strategy and organization", "employees and behavior" and "IT") is calculated. In the third layer, the field scores are adjusted for cross field influence and in the final layer, we calculate the KM performance score.
Because our model also has an output on the factor- and field level, it can be used to point out weak spots in the KM of an organization.
When the model is filled in before and after a KM initiative, the changes in scores can be used to evaluate the effect of this initiative on the various aspects of KM.
This output can also be used in benchmarks. Leal et al. define benchmarking as "an ongoing process aimed at identifying, measuring, comparing and learning the bases for other companies' competitive advantages, regardless of their being competitors or not, and which explain their success" [29].
Besides that, Arisha states that standardized, generic frameworks, like ours, allow benchmarking [1]. We measure the performance of companies according to employees in various factors and fields that influence KM. Because we measure the views of employees, people can use our model to compare how organizations perform in the eyes of their employees.

4.2.4 The first layer

Strategy and organization

In the field of "strategy and organization" we used six factors to determine a preliminary factor score. We used the median score of these factors in the survey to determine their relative weights. The factor scores (1-10) will be multiplied by this weight and added up to each other. This sum will be divided by the sum of the weights (46) in order to calculate the preliminary field score on a 1-10 scale.

"The existence of a clear KM strategy" had a weight of 7. The weight of "An organizational culture that supports sharing of new knowledge and the usage of existing knowledge" is 9. "Sufficient facilities within the company to come together and share knowledge" and "Availability of existing knowledge" both get a weight of 8 and "Cooperation between business units" and "Retainment of experienced staff" get a weight of 7. In the Appendix (8.4), we provide an example of how the calculation of the initial field score works.
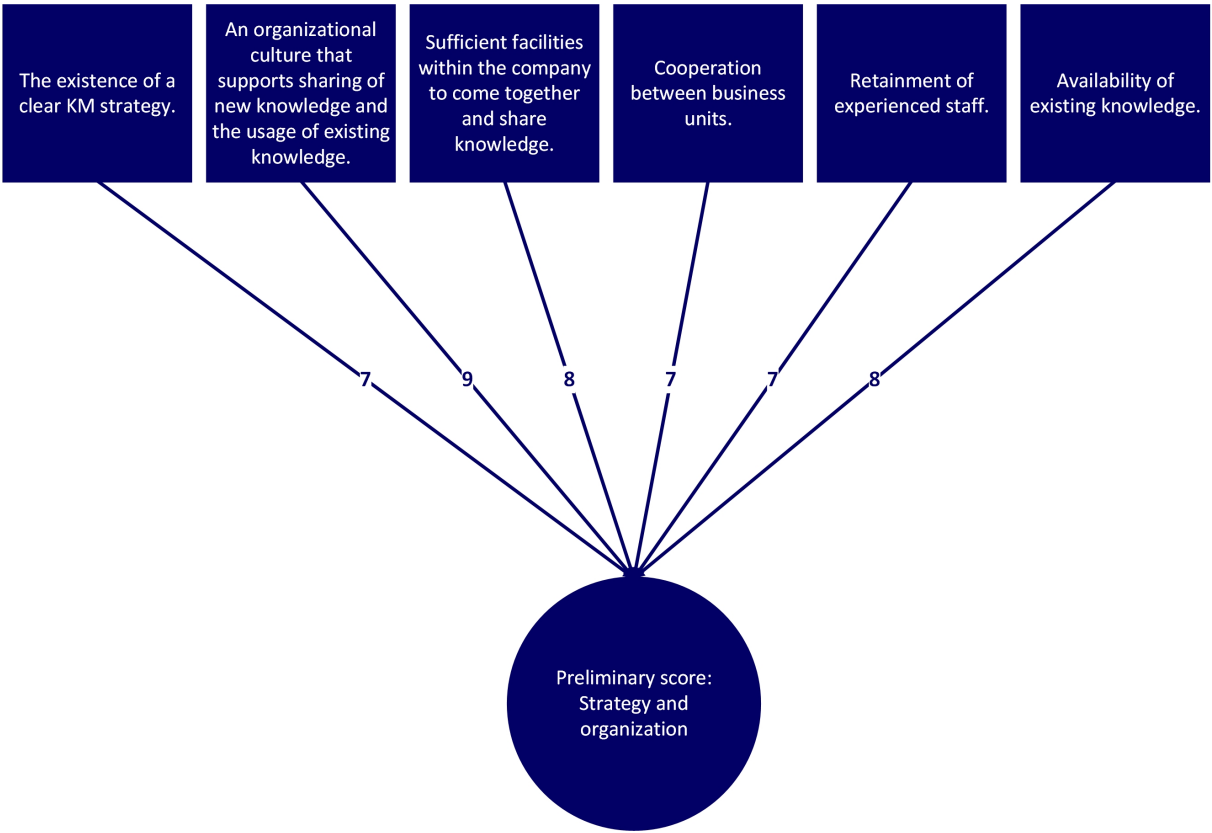
Figure 2: The weights of factors in the field of "strategy and organization"

Employees and behavior

In the field of "employees and behavior" we also used six factors to determine a preliminary factor score. Just like in the field of "strategy and organization", we used the median score of these factors in the survey to determine their relative weights. The sum of the fields and their weights will be divided by the sum of weights (45) in order to calculate the preliminary field score on a 1-10 scale.

"Sharing of knowledge among employees", "Sufficient understanding among employees on how to handle knowledge" and "Cooperation of employees toward a common goal" get a weight of 8. "Sufficient documentation of research and projects", "Motivation and commitment of employees towards the KM strategy" and "Usage of the available tools to save and share knowledge" get a weight of 7.
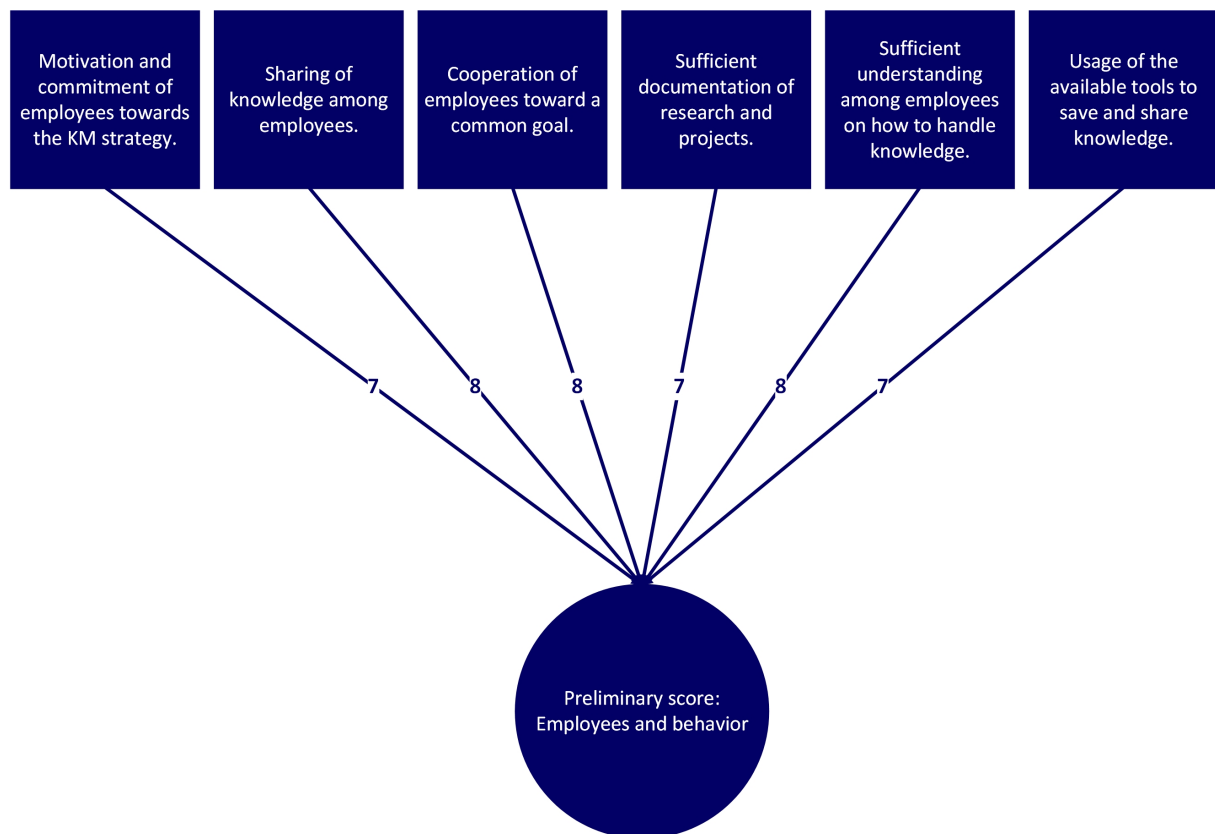

Figure 3: The weights of factors in the field of "employees and behavior"

IT

In the field of "IT", just like in the other fields, we used six influence factors. We used the median score of these factors in the survey to determine their relative weights. In order to calculate the preliminary field score we take the weighted average of the factor scores.

"Sufficient training of users to use content sharing systems", "Clarity among all users on what systems are supposed to be used", "Technical solutions that are in line with the needs of the organization and compatible with existing processes" and "Content sharing systems that are easily available" get a weight of 8. "Usage of the same systems by all employees to save and share knowledge" and "Sufficient technical support" get a weight of 7.
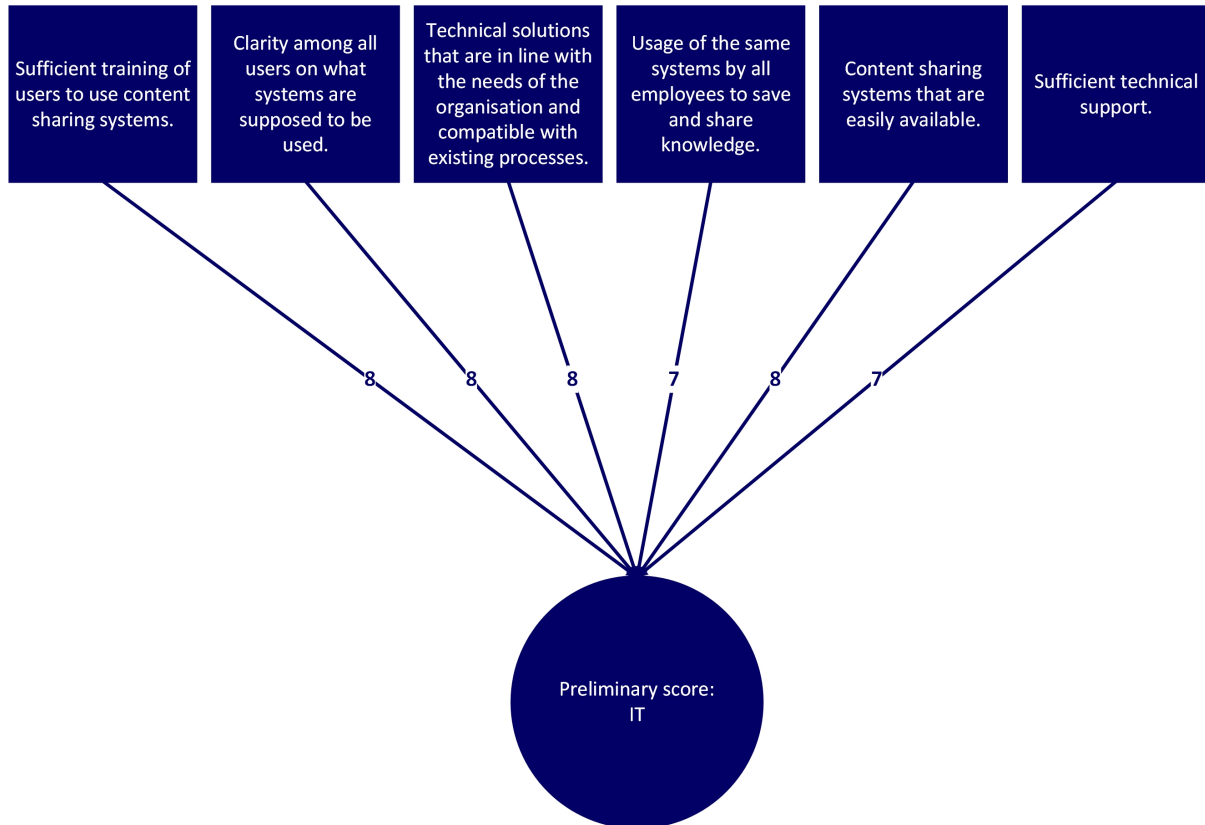

Figure 4: The weights of factors in the field of "IT"

4.2.5 The second layer

Our survey respondents were asked to value fields, on a 1-10 scale, based on the influence that these fields have on factors in other fields. From the field average of their median scores per factor. we calculated an average cross field dependency on a scale from 1 to 100.

We see that the influence of "strategy and organization on "IT" and on "employees and behavior" and the influence of "employees and behavior" on "strategy and organization" are all between 72/100 an 78/100. The influence of "IT" on the other factors and the influence of "employees and behavior" on it are scored between 57/100 and 62/100. All fields have a weight of 100 in calculating their own adjusted field score.

In Figure 5, we see the cross field influence of our three main fields. The initial field scores are multiplied with their weights and that total is divided by the sum of the weights of influence of the three initial field scores. In Appendix 8.4, we provide an example of how the calculation of the adjusted field scores works.
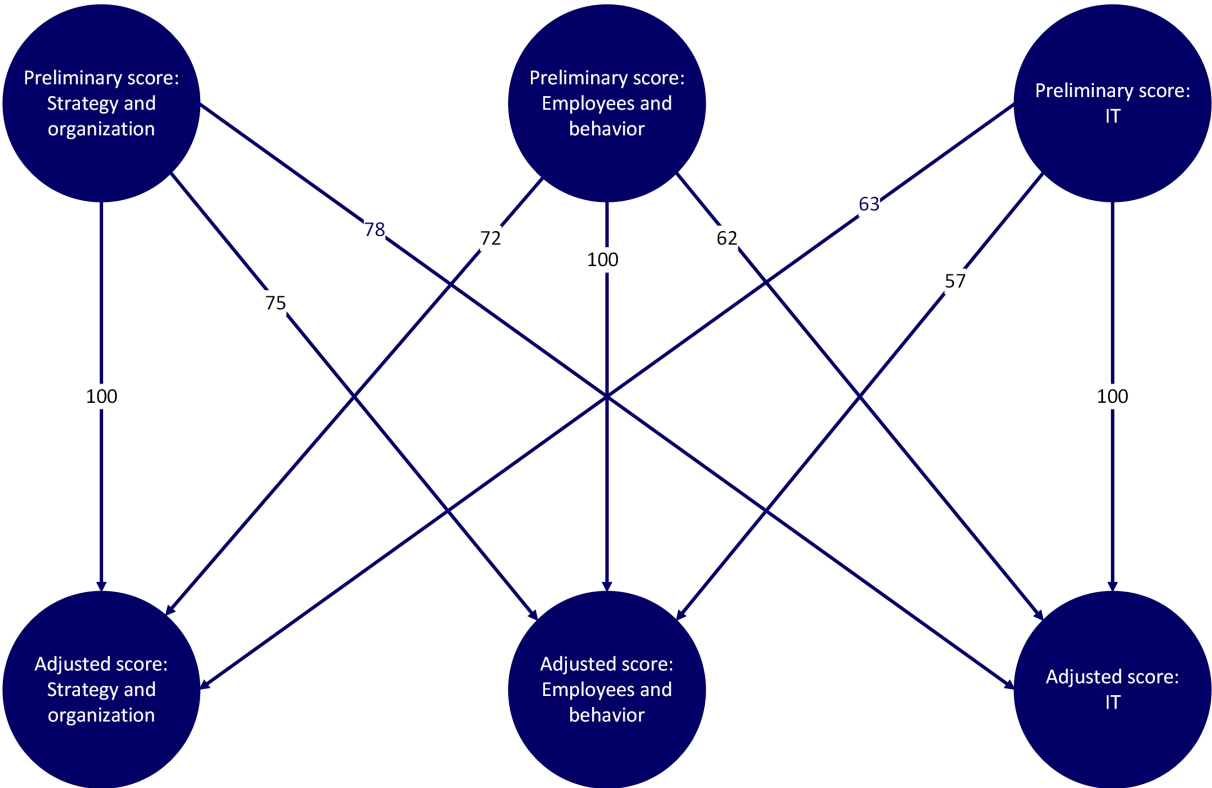

Figure 5: The weights to adjust for cross field influence

4.2.6 The third layer

In the third layer, the adjusted field scores get a weight. This weight determines their influence on the total score. The weights are determined according to the median influence score given by our survey respondents. "strategy and organization" scored an 8/10, "employees and behavior" scored a 9/10 and "IT" scored a 7/10. In Figure 6, we show how our respondents scored the influence of our three main fields on successful KM.
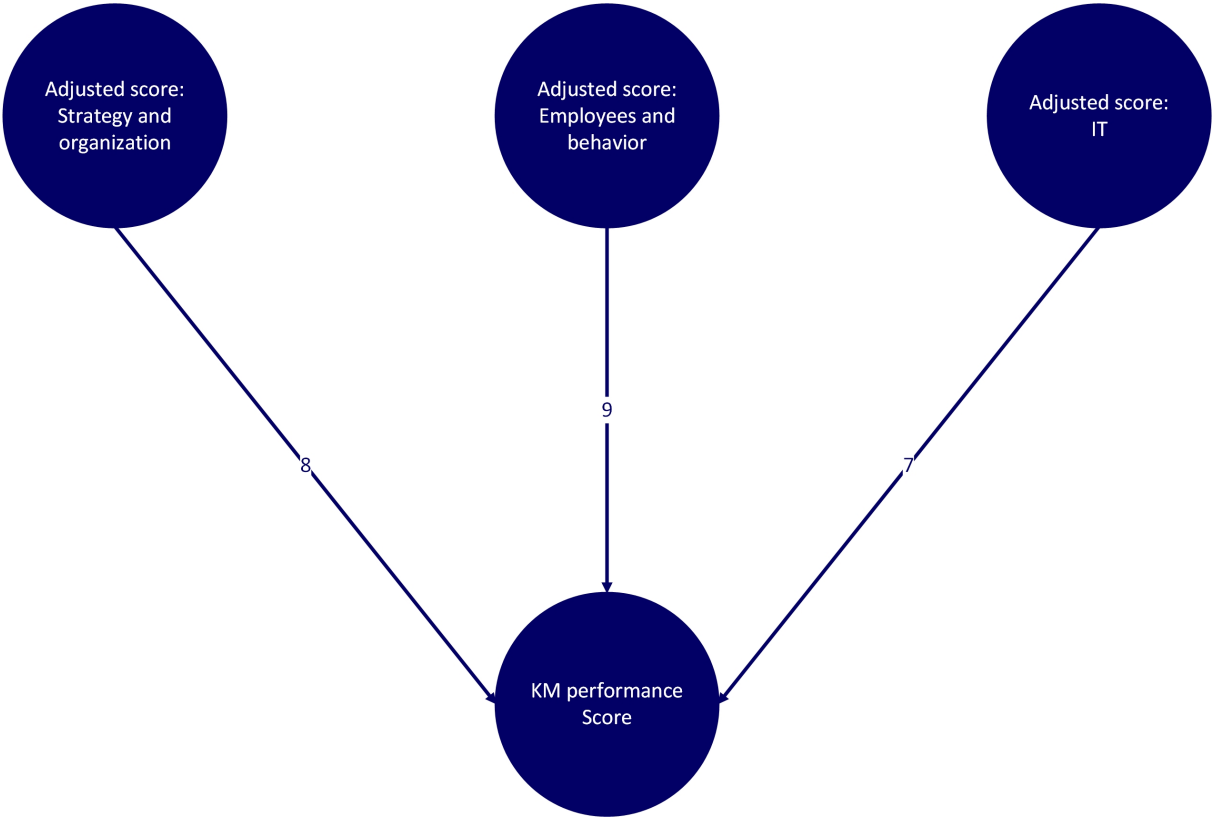
Figure 6: Calculating the KM performance score

4.2.7 The fourth layer

In the fourth layer we calculate a final score. This score is divided by the sum of the weights (24). This score can be used in bench-marking, evaluating KM initiatives and measuring KM success. The initial field scores in the second layer and the factor scores in the first layer can be used to see on what level organizations perform on certain aspects of KM. All scores range from 1 to 10. Organizations can use the score to measure their progress over the years, measure the effect of initiatives and compare their scores to other organizations in a benchmark. In Appendix 8.4 we show how our model works with a random input.

Figure 7: The four layers in the proposed model

5 Discussion

In this section, we will discuss the choices we made in developing our measurement model and compare our model to existing measurement methods.

5.1 The rationale behind our model

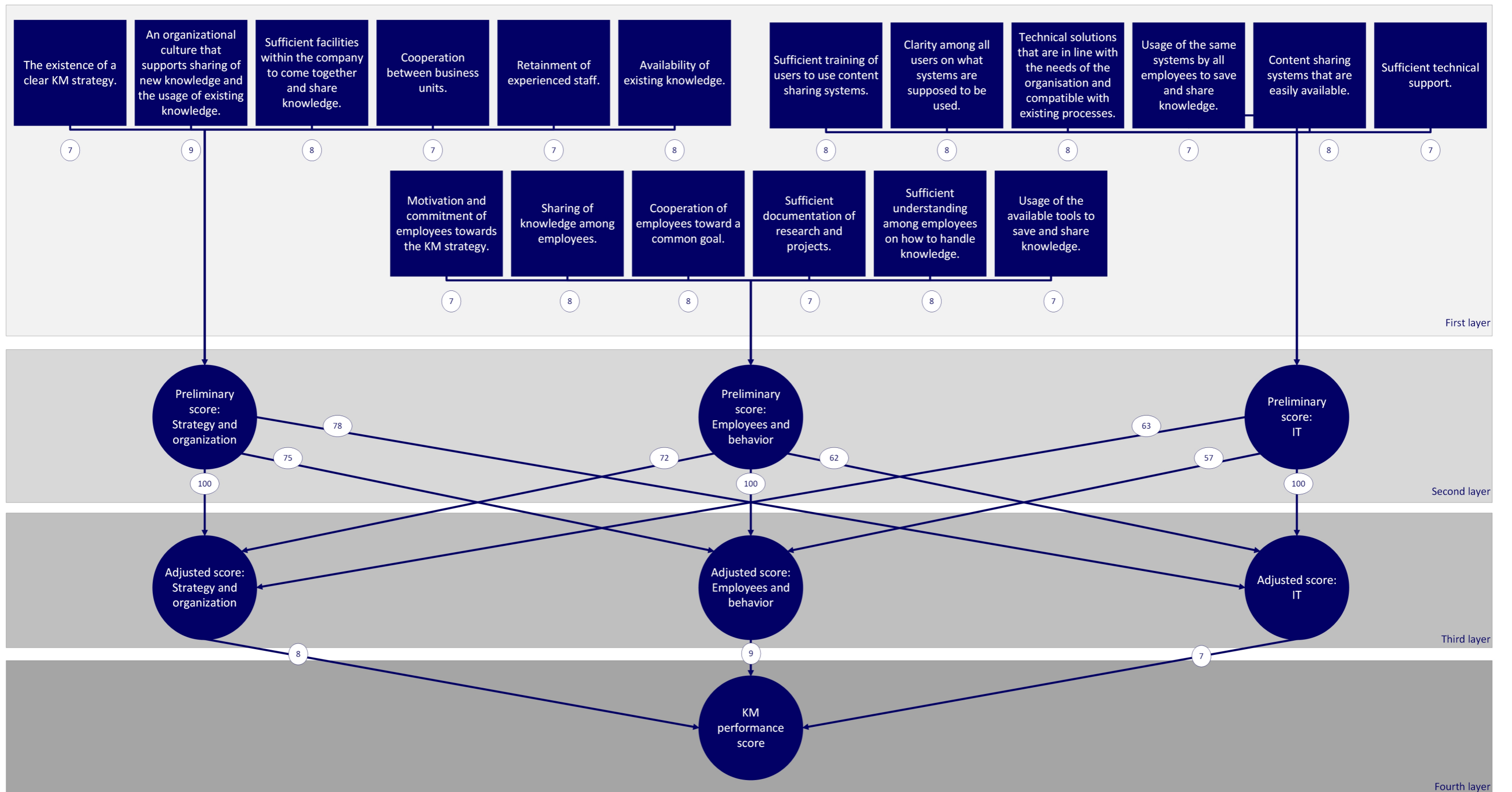In this subsection, we will discuss the choices we made in developing our model. We will cover the input that our model will need, the relation of our factors and fields to KM, the weights that we retrieved from our survey and how the output of our model should be interpreted.

5.1.1 Input

We have chosen to use the results of a survey under employees (see Appendix 8.3) as the input data for our model. In this survey we will ask the employees to what extend they agree that our 18 success factors correspond with the current situation at their organization. Then we will take the median of those answers and put that in to the model as factor score. According to Leys et al, the median is more robust than the mean when the data consists of uni variate data with outliers [30]. Therefore, we use the median instead of the mean in order to lower the influence of outliers.

We have chosen to base the input for our model on the opinions of the employees instead of numerical data, like for example amount of data in a content sharing system, because we believe that the way employees experience KM is more indicative to it's success than assumptions based on other indicators.

This choice is substantiated by the fact that Wu and Wang state that "user satisfaction is a good measurement for KMS success." [58], the fact that "employees and behavior" was seen as the most important field in KM by our survey respondents and the fact that Thomas states that KM is deeply social in nature [53]. In order to get a good representation of the situation, the survey respondents must be an accurate reflection of the composition of the workforce.

We have chosen to use a survey instead of for example interviews or a workshop for two main reasons. Firstly, our model only needs answers to a previously determined set of questions. The answers have to fit the input for our model and therefore all information that is not a 1-10 rate of agreement to the statements in our survey can't be used in the model. Additional information or context that could have been better caught, using an interview or a workshop would have no additional value. Secondly, our model had to be practical and take as little effort as possible to use. The time and cost associated with interviews and workshops would have made our model far more time consuming.

5.1.2 Factor influence

The influence of factors within our fields is the first layer of our model. The weights of these factors are based on the median score that the respondents gave to them in the survey. The small group of respondents (19) results in a relatively large influence of outliers on the mean. According to Leys et al, the Median is better than the mean when data is uni variate and has outliers [30]. Therefore, we have chosen to use the median in stead of the mean.

Strategy and organization

In the field of "strategy and organization", we singled out six factors that influence KM success. Our first factor, "The existence of a clear KM strategy", influences KM because people in an organization should know what they have to do, and for what purpose they have to do it. Roghab and Arisha stated that KM should be aligned with the business strategy. "Standardized and documented KM policies and procedures" also help people to understand how they need to handle knowledge [1]. With an influence score of 7/10 it is one of the least influential factors in this field according to our respondents. This shows that even though the respondents think that this factor has influence on KM, they do believe other factors to be more influential. We believe that they rated the strategy lower than the other factors because the other factors are things they come in to contact with on a daily basis. The influence of the strategy would feel less direct.

"An organizational culture that supports sharing of new knowledge and the usage of existing knowledge" is seen as the most important factor (9/10). The organizational culture is important because knowledge sharing is the most important part of KM. According to Krogh, people won't share their knowledge if they are not motivated to do so because they are afraid to loose their value to the company [57]. Besides the culture of sharing, sufficient facilities to share knowledge are important. These facilities could be IT facilities but one could also think of, for example, company drinks. According to Roghab and Arisha, organizations need to provide the right infrastructure to make the sharing of knowledge as easy as possible. This goes further than IT. Organizations need to adopt a holistic approach that supports KM. Apart from a good IT infrastructure there should be places and time for employees to physically come together and share knowledge [1]. The factor "Sufficient facilities within the company to come together and share knowledge" covers this aspect. This factor scores averagely compared to the other factors in this field with a score of 8/10.

"Cooperation between business units" is important because it prevents double work when both business units need the same information. Knowledge sharing thrives in a culture of communication and teamwork [1]. In order to work together efficiently, you need to share knowledge and in order to share knowledge, you need to communicate. Not all business units need to cooperate. Where cooperation between, for example, sales and business development could be important in order to develop products that fit market needs, other business units could function perfectly on their own. This makes this factor relevant fore a lot of people in the organization, but not for all of them. In order to prevent the loss of experience and knowledge it is important to focus on the "Retainment of experienced staff". When KM is perfectly performed, one could argue that this factor becomes irrelevant. Organizations must be able to convert the knowledge and experience of their employees to corporate knowledge, so it won't be lost after an employee leaves the company [25]. We, however, do believe that it is impossible to extract the totality of someones knowledge and therefore that the loss of experienced people will always result in the loss of knowledge. These two factors both score a 7/10 and therefore are among the least influential factors in this field. "Availability of existing knowledge" prevents double work when existing knowledge is reused instead of researched for a second time. A score of 8/10 places this factor in the middle of this field when it comes to influence score. All factors score 7 or higher and therefore we believe them all to have a lot of influence on KM success.

Employees and behavior

We have also singled out six factors in the field of "employees and behavior". "Motivation and commitment of employees towards the KM strategy" is important because a strategy has no value when people don't act accordingly to it. Malhotra and Galletta state that employee commitment and motivation affect the performance of knowledge management systems [34]. Another factor in this field is "Usage of the available tools to save and share knowledge". In order to keep knowledge easily available for the people that need to use it, employees should use the correct tools to save and share their knowledge. According to Riege, commitment to the IT system by people within the organization is very important. If there is reluctance to use them, the IT systems will not generate the intended effect [46].

Written documentation is a part of KM. Knowledge that is documented won't be lost when the responsible employee leaves the organization. Jones states that this makes it very important to convert employee knowledge to corporate knowledge [25] and therefore "Sufficient documentation of research and projects" is a factor in our model. These three factors are seen as a little less important than the following three factors. They score a 7/10 in our survey on the influence of factors on success full KM.

The hoarding of knowledge can do harm to a company. When knowledge is shared, it is used more effectively [25]. We cover this with the factor "Sharing of knowledge among employees". Collaboration and interaction are important to transmit tacit knowledge and convert it from individual to organizational knowledge [19]. Therefore "Cooperation of employees toward a common goal" is a factor in our model. "Sufficient understanding among employees on how to handle knowledge" is important. Rohab and Arisha state that when people know how to handle knowledge as a result of that training, they will be far more effective in KM [1]. These three factors are seen as the most important factors in this field with a score of 8/10. Just like in the field of "strategy and organization" all factors get a score of at least 7/10 and can therefore be seen as very influential to KM success.

IT

The last field in which we found 6 factors that influence KM success is the field of "IT". Just like in the other fields, all factors get a median score of 7 or higher. "Sufficient training of users to use content sharing systems" is important because training is a critical part of all IT system implementations [56]. It is also important to have "Clarity among all users on what systems are supposed to be used" because otherwise, people will save information- and look for information in the wrong places. This will make knowledge less easily available and therefore goes against one of the goals of KM. Riege states that the IT systems will not generate the intended effect if they are not used by the people that are supposed to use them [46]. "Technical solutions that are in line with the needs of the organization and compatible with existing processes" were seen as the most important factor by our survey respondents. Technical solutions only work if they are tailored to the needs of the organization. If they are to complicated to use for the employees or if they don't fit business processes, they won't be used. According to Riege, sharing knowledge trough IT is inhibited when IT systems and procedures do not comply with the way the organization works [46]. An organization also needs "Content sharing systems that are easily available". According to Davenport, access is an important part of KM [14]. Getting people to use the correct systems isn't easy and one of the solutions to this problem is making it as available as possible. Both finding and storing knowledge should take as little energy as possible in order to get people to use the system. The above mentioned factors score 8/10 in our survey on factor influence in KM. This makes them the most important factors in this

field.

"Usage of the same systems by all employees to save and share knowledge" is also very important. It results in the fact that all knowledge is stored and available at the same place. We should note that multiple systems within an organization are possible if different parts of the organization have different needs when it comes to knowledge sharing. Some departments might need more extensive software than others. The people that use the same knowledge in those departments, should still use the same software. Just like with any other technical systems there is a need for "Sufficient technical support" [46]. The system needs to be kept up and running and problems that occur need to be tackled as quickly as possible. Downtime means that people can't store their knowledge where they should and that defeats the purpose of a KM system. The last two factors score a little lower than the first four. We believe that respondents attach a little less value to the usage of the same system by all employees because they work in a situation where this is not the case. If they aren't used to a system were they can find all the available information, they might not see all the advantages. The lesser score of technical support can be linked to the lower score of "Usage of the same systems by all employees to save and share knowledge". When people don't see the importance of storing all information in one place, saving their files locally when the system is down won't feel like such a great issue. However, with a score of 7/10, we can still call them influential when it comes to KM success.

5.1.3   Cross field influence

The second layer of our model, in which we adjust for cross field influence, will be covered in this subsection. Based on the influence of fields on factors in other fields we calculated the cross field influence in the results section (see Section 4.2.5). The field of "IT" has the least influence on other fields (63, 57). This was to be expected because of the lower influence of "IT" on KM success as a whole.

The influence of "strategy and organization on the other 2 fields is greatest. This is not in line with the direct field influence on KM, because "employees and behavior" scores higher in direct influence. This seems contradicting, but it is not. The influence of employees on the strategy is lower than the influence of the strategy on the employees. This is logical because the employees have to work in accordance with the strategy but they aren't the ones that decide on strategic matters. Also, a higher cross field influence does not have to imply a higher direct influence. Besides that, the difference in how these two fields influence each other is small. The influence of "strategy and organization" on "employees and behavior" (75) is only 4 points higher than the other way around (71).

The influence of "employees and behavior" on "IT" (62) is a little lower than the influence of "strategy and organization" on "IT" (78). This is logical because IT solutions are part of a strategy and employees have little influence on what IT solutions are used. According to our respondents it is very important that IT is in line with the needs of the organization so one could argue that the influence of employees on IT should be higher to support optimization of KM.

5.1.4 Fields

In this subsection we will discuss our choices with regard to the third layer in which the field scores are combined into a total score.

Based on the perspectives of Fairchild [17], Liebowitz [31], Tseng and Lee [55], Riege [46] and Gold [19], we formed 3 fields that influence an organization's KM performance. The social perspective from Fairchild and the human perspective from Fairchild, Liebowitz, Tseng and Lee, the culture perspective from Gold and the individual barries from Riege were the basis for our "employees and behavior" field. Our "Strategy and organization" field is based on the structural perspective that Liebowitz, Gold and Fairchild spoke of and the organizational barriers from Riege. The field of "IT" is based on the technology bariers from Riege, the technological perspective form Gold and the technological performance measurement from Tseng and Lee.

According to our survey, the respondents thought "Employees and behavior" to be the most important field. Because the median is more reliable in uni variate data with outliers [30], we have chosen to base the weight of the field on the median score in order to minimize the influence of outliers. With a median of 9/10, we see that this field is seen as extremely important by our survey respondents. This is in accordance with literature, where the social and human perspective are stated to be influential to successful KM. According to Thomas et al. KM is deeply social in nature [53] and Riege, Mc Dermot and Cabera see the sharing of knowledge among people in the organization as very important in KM [46, 38, 11].

The second most important field is "strategy and organization". Based on the median, our survey respondents rated it 8/10 and all of them thought it had an influence of at least 3/10. We believe that strategy is seen as an important field because it is about the big picture. It is less important than "employees and behavior" because strategy is useless if employees don't act according to it. Zheng states that strategy has a significant impact on KM [59].

"IT" is seen as the least important field with a median of 7/10. Even though it is less influential than the other fields, it is still an important facilitator. Sher and Lee found that IT, besides the organizational and behavioral dimensions of KM, is important in order to enhance dynamic capabilities [51]. We believe IT scores lower than the other fields because it is only a facilitator. IT has no value if it is not used by employees and should always be aligned with the strategy. This does not mean that IT should be ignored. IT enables organizations to store enormous amounts of data and makes knowledge more accessible. Therefore IT is still seen as an important part of our model.

5.1.5 Output

Our model provides output at multiple levels. In the first level it rates the performance of the organization on a 1-10 scale on a factor level. In the second layer it rates the performance of the organization on a field level (also on a 1-10 scale) and in the fourth level, it scores the overall KM performance of an organization on that same 1-10 scale.

The scores indicate to what extend the employees experience the results of KM efforts. The results do not state what an organization is doing with regard to KM but rather to what extend their efforts affect their employees. We wanted to focus on the employee point of view because people are the most important factors in KM. Different people, need different approaches and our model measures how well these approaches help the employees in successful KM.

The scores can be used to pinpoint the current state of knowledge management at an organization and Arisha stated that standardized generic frameworks, like ours, can be used for

cross firm comparisons [1]. They can also be used to measure the effects of KM initiatives and reveal what factors and fields need extra attention.

The results are valid to the extend that all factors that are used in the model do positively affect KM. A problem with our model is that it does not account for the different levels that factors need to be on for successful KM. A score increase from 5 to 6 has the same effect in the final score as an increase from 9 to 10 even though the result of the first increase might have a way larger impact on overall KM performance.

5.2 Comparing our model to other measurement methods

In this section, we will discuss how our model differs from other methods that were developed to measure KM. We will also underline the similarities and cover the added value of our model to the field. We will discuss aspects of the common methods to measure Intellectual Capital (IC), Fairchild's Knowledge Centric Organization (KCO) method which is based on balance scorecards [17], Shanaks framework for measuring KM success [50] and Gold's model for measuring organizational capabilities [19].

Measuring intellectual capital

The rationale behind these methods is the fact that the value of a company is assessed based on intangible assets in the same manner as the tangible assets. According to Roos, Intellectual capital is a combination of "human capital" and "structural capital". Human capital consists of competence, attitude and intellectual agility. Structural capital consist of relationships, organization, renewal and development [48]. One might argue that these are similar to the fields of "employees and behavior" and "strategy and organization". An important difference is that our model does not account for the competences of employees. However, it does measure the extend to which they are trained and how the KM solutions are aligned with their competences and needs.

Bontis has some critiques on this method "Although an exciting perspective to most managers, IC still remains elusive and restrictive. The tremendous growth of contributions and applications over the last decade has not addressed all the limitations yet." [8] He states that metrics are often too firm specific and there is to little generalization.

The IC measurement system is built on two types of indicators. The key success factors and the factors that create value. These indicators are chosen based on the strategy of the company. This means that this model is different for all organizations that use it and can not be used to compare different organizations. External comparison is only possible when the goal is to compare growth but not to compare the current situation.

Bontis states that "While it is true that the consolidation is a step forward towards inter-company comparisons, even in this case IC performance (i.e. changes in IC levels) is the only element that can be compared, and then only if the two companies under consideration used similar IC systems."[8]. Because our model is aimed at the views of employees, that exist in all companies, our model is more suitable for external comparison.

The fact that Arisha stated that standardized generic frameworks, like ours, can be used for cross firm comparisons and models that are tailored to specific organizations, like the IC measurement system, can not [1] reaffirms this.

The flexibility of this method can also be seen as a strength. The measurement method can be better fitted for one specific organization than our model in which the metrics are fixed.

Fairchild's KCO method

Fairchild's KCO method [17] is based on the idea behind balanced scorecards. The method is used to establish how KM is leveraged in organizations. Just like with balanced scorecards, KCO uses four perspectives. Fairchild proposed two approaches.

In the first approach she uses a structural- , intellectual- , social- and human perspective. The structural perspective could be compared to the "strategy and organization" field in our model and the social and human perspective can be compared to our "employees and behavior" field. The intellectual field is not covered in our model. This perspective is aimed at the existing skills of people and existing knowledge and our model focuses only on how existing knowledge and capabilities should be handled.

In the second approach, she uses an employees- , a customers-, a processes- and a technology perspective. The employee perspective can be compared to our "employees and behavior" field, the processes perspective can be compared to our "strategy and organization" field and the technology perspective can be linked to our "IT" field. The customer perspective is not used in our model because we see customer satisfaction as a possible result of successful KM. Successful KM can, among other factors, lead to higher customer satisfaction but high costumer satisfaction does not directly imply successful KM.

Fairchild proposes to use measurable metrics that aim at the effort put in KM (for example internal hours on KM process improvement and investment in KM technology) as the input for his model. We have chosen to use a survey for measuring the effect of KM in the eyes employees rather than the effort that is put in to KM. We chose this approach because we believe that, because of the deeply social nature of KM according to Thomas [53], the experiences of the employees are the best indication for the success of a KM strategy and therefore, their views on whether it is working are more important than the effort put in to it. Our model is also easier to use because all the metrics used by Fairchild must be generated and calculated and in our model we only need to survey the employees.

The methods (Fairchild's and ours) could be used complimentary to each other to see if KM efforts have the desired results according to the view of the people in the organization.

Gold's model for measuring organizational capabilities

Gold et al. developed a model to measure knowledge management capabilities and organizational effectiveness [19]. The model differs from our model in that Gold's model has an extra layer in which it combines 'knowledge infrastructure capability' and 'knowledge process capability' into 'organizational effectiveness'. Gold's model is aimed at measuring organizational effectiveness where our model is aimed at KM performance. Gold's model bases its final score on two KM dimensions. The knowledge infrastructure capability dimension measures three sub dimensions: "technology", "structure" and "culture". The knowledge process capability dimension measures four sub dimensions: "acquisition", "conversion", "application" and "protection" [19].

Massingham et al. criticize Gold's model. "Attempts to prove KMs capability, by decomposing Gold et al.s (2001) model, have produced mixed results." [37] They state that not all aspects of Gold's model are influential to organizational performance "If Gold et al.s (2001) model is disaggregated, this suggests that some processes and some infrastructure may help the firm, but others do not. Those that do help provide only intermediate impact." [37] Also, Massingham et al. do not agree with the fact that Gold's model assumes an impact of KM capability on firm performance [37]. Therefore we decided to aim our model exclusively at the measurement of KM performance instead of financial- or overall performance.

Another important difference between Gold's model and ours is the fact that Gold's model has more parameters (57 factors to our 18) and therefore is more complex. According to Myung "There are at least two independent factors of model complexity that can significantly affect model fit, namely the number of parameters and functional form. The latter refers to the way in which the parameters are combined in the model equation" [40]. This means that even though Gold's model provides the user with more information, it is more complex and Arisha stated that models should be straightforward enough to be understood by end users that need to apply them [1]. Golds model is best suited to use for in dept measurement of the state of KM. Our model is better suited to use by practitioners to get a quick overview of the current KM situation.

Despite the differences, various aspects of the two models are comparable. The strong cross dimensional influence between culture and structure compared to the cross dimensional influence between technology and the other dimensions looks like the cross field influence of "strategy and organization" and "employees and behavior" compared to the cross field influence of "IT". Also the factors are quite similar. The focus on the collective and working together, the importance of knowledge sharing and the importance of including employees play a prominent part in both models.

Our model is most comparable to the knowledge infrastructure capability dimension in Gold's model. The sub dimensions could be directly translated to our fields. The aspects of process capabilities that are included in our model are processed into factors in our three main fields. According to Mills and Smith "some knowledge resources (e.g. organizational structure, knowledge application) are directly related to organizational performance, while others (e.g. technology, knowledge conversion), though important preconditions for knowledge management, are not directly related to organizational performance" [39]. This reaffirms that our model can only be used to measure KM performance and not to measure organizational performance.

The weights in Gold's model are better supported because their survey group (over 1000 respondents) was larger than ours, but there are no great discrepancies between the weights in Gold's model and the weight in ours. Therefore we can assume that our result would not have been much different if we would have used a larger survey group. This assumption could be verified by conducting this survey again on a larger survey group. Our survey is more relevant when it comes to the current situation (2018 against 2001). Some of the factors in Golds model are outdated because they have become common in every organization. For example, the fact that a company uses technology to search for new knowledge and that employees use technology to collaborate with other people in the organization. However, the fact that these factors are included in Gold's model does not have a very large impact on the model's results.

Shannak's framework for measuring KM success

Shannak researched "which performance indicators should be used when measuring performance of activities in knowledge management systems"[50].

Shannak proposed a categorization in which the main focus area's were process, human and IT [50]. This can be translated to our three main fields. In those area's he defined four domains. In the Human focus area, for example, the domains are "knowledge sharing attitude", "knowledge sharing activities", "use of/ participation in activities" and "awareness". These domains are quite similar to our factors and, just like in our model, sharing of knowledge, awareness and usability are named as important aspects of KM.

For these domains he found performance indicators for which survey's and logs in databases could be the input sources. This differs from our model were the input is fully provided by a survey.

Shannak used four ways to express performance indicators: The amount of times an event takes place, A ratio of the amount of events that took place the amount that could have taken place, a percentage and a boolean [50]. Our metrics are always scores on a 1-10 scale based on the views of employees. Shannak's approach is more objective, but the required amount of, for example, time spent on training employees that is required for an organization can vary based on the skills and needs of the employees. An objective measurement method, like Shannak's, that uses this factor, does not account for the different requirements of organizations. Therefore, we attach more value to including the views of employees than to the objectivity of our model. The greatest difference between Shannak's research and our model is that Shannak only identified the metrics and categorized them. We went a step further by establishing their weights. Therefore, our model could be used to measure how good an organization is performing in KM. Shannak's research can be used to reveal what factors are influencing KM and can be used to evaluate KM initiatives on a level comparable to our first (factor) level. In this level Shannak's method is broader than our model and less dependent on interpretation of employees because of the use of database logs.

6   Conclusion

In this section, we will answer our research questions and cover the limitations of our research. We will also provide our recommendations for future research.

6.1   Answering the research questions

In this subsection, we will answer the question "How can we asses the effectiveness of knowledge management, using a practical measurement method?" In order to answer that question we will first have to answer our sub questions.

6.1.1   What are the factors that impact the effectiveness of KM and how strongly do these factors relatively weigh in to the success of KM?

KM is influenced by various factors that we divided up into three fields. In order to answer this research question we will cover these three fields and their most important aspects. In our discussion about our proposed model (see Section 4.2) we included all factors that influence KM and their relative weights.

The field that is most influential on KM is the field of "employees and behavior". People in an organization should be included and motivated to participate in KM. It is important for employees to understand how they need to handle knowledge and why KM is important. Employees should work together and share their knowledge in order to work efficiently and prevent reinventing the wheel.

The second most important field is the field of "strategy and organization". KM needs to be built around clear processes and long term goals. It is also important to create a culture that is supportive of the sharing and re-use of knowledge and to provide sufficient facilities to share knowledge and to make knowledge easily available for employees.

The third field that we identified, the field of IT, is of lesser importance than the other two fields but still has significant impact on KM success. IT should be seen as an enabler. IT can make KM easier or, if ill managed, harder. In order to be an effective enabler of KM, IT solutions should be aligned with the processes and the needs of employees. Sufficient training on what and how systems should be used is vital and systems should be easily available.

Research into other models shows a comparable view of both the weights and the fields and factors. The factors within the fields are difficult to compare because they are formulated in different ways, but they generally cover the same aspects of KM. The weight difference between factors is small. In, for example, Golds model, the most important factor has a weight of 86/100 and the least important factor has a weight of 75/100. In our model, the most important factor has a weight of 9/10 and the least important factor has a weight of 7/10.

When it comes to cross field influence, the differences are small as well. The 'culture' and 'structure' (Gold's model) and the 'employees and behavior' and 'strategy and organization' (our model) have a stronger relation to each other than to IT in both models.

When it comes to the influence of fields, both models assign the highest weight to 'culture' and 'employees and behavior. In our model, 'strategy and organization' is more important than 'IT'. In Golds model it is the other way around. However, the fields are, in Golds model, seen as of almost the same influence (70/100 and 71/100). In the final score, this difference does not lead to significantly different insights.

6.1.2 What are the requirements for a method that measures KM success?

Based on our research, we believe that there are 4 requirements for a successful KM measurement method. In answering this research question we will shortly explain those four requirements.

The first requirement is that the method should be easily usable in a corporate environment. A new model should be clear and pragmatic. The method should be understandable for consultants and strategy managers and not only for people with a research background. The method should not take to much time and effort to use. This is important because measurement methods that aren't practical and understandable won't be used in practice.

Our second requirement is that, because of the deeply social nature of KM, the people in the organization should be an important part of the measurement method. The success of knowledge management can be measured using user satisfaction. The fact that employees and behavior were very important according to our survey reaffirms this.

The third requirement is that KM performance measurement should go further than traditional (financial) measures. Non-financial measures are more relevant in tracking progress.

Our fourth requirement is that the method, when it has to be used for external bench marking, can't be to company specific. Only generic frameworks can be used for cross firm comparison. This means that that scores of different organizations could be compared to each other to see who performs better.

6.1.3 How can we asses the effectiveness of knowledge management, using a practical measurement method?

The effectiveness of knowledge management can be measured in various different ways. Firstly, you need to decide on the input for the measurement method. You can use numerical data that is generated from devices and applications like the logs of KM systems or you can use soft data, that is based on interpretation, like the views of employees. In our model, we have chosen to focus on the way employees experience KM because employees were most influential to KM success according to our survey. Numerical data, like the amount of money spent on training employees, could be seen as more objective but the level of training that is required for an organization can vary based on the skills and needs of the employees. Therefor, we believe its, for example, more relevant to measure whether the employees are satisfied with the level of training than it would be to measure the amount of money or hours spent on that training. Soft data could be obtained via interviews or via a survey. We have chosen to use a survey because we need a certain input for our model that does not leave space for additional information. All the information we need is to what extend the respondents agree with the statements in our survey and that information can be obtained using a survey. Besides that, interviews take more time and effort and we wanted an easily usable measurement method. When extra dept is needed or when the results of or model need to be examined, interviews could be a better option.

Some factors can be measured based on numerical data such as logs. The usage of a certain KM system is an example of a factor that could be objectively measured by looking at the logs of the system.

There is no absolute truth about what method should be used to measure KM success. The methods that we researched were based on roughly the same factors and fields that influence KM. Also, the difference in the relative weights of these fields and factors wasn't big enough

to result in significantly different conclusions. However, the models differ in dept, input and goal. The method that should be used depends on the reason behind the measurement.

When an organization wants to measure the effort put into KM, they should not be using our model. They should use a method that uses numerical data about the effort put into KM instead of the results of those efforts according to employees. The amount of money spent on KM or the time spent training employees is an example of the data that such a method would use. When an organization wants to measure the effectiveness of their KM, they should use a model based on the views and experiences of people in the organization. A combination of these types of measurement methods could be used to measure whether KM efforts are leading to the intended result. Some methods are more complicated than others and provide an extensive overview of all aspects of the factors that influence KM. These methods take more time and effort to use and could be used to measure KM success over long periods of time. Other methods provide a less extensive overview but also take less time and effort. These methods could be used for a quick scan of the current state of KM in an organization.

When organizations are only interested in finding out what factors influence KM performance and what initiatives could help to improve their KM, an extensive framework, outlining the factors that influence KM, can provide the answer. Such a framework could provide organizations with an extensive overview of potential area's in which they could make improvements in order to improve KM performance.

Our proposed model should be used by organizations who want to perform a quick check on the state of their knowledge management. When a more extensive check is needed, Gold's model could be used. One could also use the model proposed by Gold every couple of years to base a new KM strategy and then use our model more frequently to evaluate whether they are still on track.

Our model can also be used to measure the effect of a KM initiative or to compare the KM performance of different business units. Because of the factor- and field scores, our model can be used to pinpoint the strengths and weaknesses of an organization when it comes to KM.

We need to take into account the limitations (see Section 6.2) of this research in order to put our model and conclusions into the right perspective.

There are various ways to measure KM success and there is no universally best tool. The method that should be used is fully dependent on the situation and the goal of the measurement. We have researched KM and the existing measurement models and, based on that research, developed a model that can be used to provide a quick overview of the effectiveness of KM in an organization. Testing both the existing models and our model in a corporate setting is required in order to establish what models perform best in certain situations and to reach a consensus about the best ways to measure KM success in both research and practice.

6.2   Limitations and future research

Our survey group was relatively small and, because of that, we had a high standard deviation in the influence scores of factors within fields. The standard deviation was, in many cases, greater than the difference between the influence of the factors. Repeating the survey with a larger amount of respondents will make it possible to create a more representative output.

63% of our survey respondents work at the same company. The views of these people can be influenced by specific situations at their company. If they, for example, had loads of problems with IT, they could, based on their experience, rate the influence of this field higher than the average respond would. However, when we compared this group to the complete survey group, we saw no significant difference in average influence score between the respondent who work at this company and those who don't. This leads us to believe that this does not cause any problems for the validity of our model. Repeating the survey on a more diverse group will take away this concern completely.

We have not tested our model with intended users. We only tested the workings of our model on dummy data. Therefore the fact that we believe that our model is easy to use is only an assumption. This assumption is based on the fact that we tried to avoid unnecessary complexity and scientific terminology and discussed our fields and factors with intended end users. Therefore, we believe our model is applicable and understandable for people in a corporate environment. Testing this model in a corporate setting can confirm this assumption or reveal how to develop a more easily usable version of this model. In future research, practitioners should be asked to measure the KM success of their company using various methods such as ours and Gold's. The results of these tests can be used to establish the usability and correctness of these models and form a basis for improvement.

In our model, we do not differentiate between factors based on what performance level is required for successful KM. It could be the case that a factor score of $7/10$ for a certain factor is just as good for successful KM as a score of $10/10$. It could also be the case that the increase from $4/10$ to $6/10$ has way more influence on KM success than the increase from $8/10$ to $10/10$. This makes our model less useful in prescribing how companies can improve their KM most efficiently. Our model does only show what factors are most important and where improvement is possible. In order to create a model that includes the required performance levels of factors, further research on the way that our factors affect KM success and the level at which they should be to maximize KM benefit is needed. This would make it possible to develop a more precise model that can be used to prescribe to what level factor scores need to increase in order to improve KM success.

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8 Appendix

8.1 The survey that was used in developing the model

8.1.1 Survey on knowledge management

There is more knowledge available than ever. Because of the rise of big data and the explosion of available data, companies hold more data than they can process. Organizations want to base their decisions on knowledge, but a lot of knowledge is not used to its full potential. In order to use knowledge efficiently and effectively, it has to be managed. Knowledge management (KM) is a process of identifying, capturing, and leveraging the collective knowledge in an organization to help the organization compete in a world that is driven by information. KM is used to increase efficiency and responsiveness.

KM strategies are implemented in order to reach the following goals:

1. Improving decision making by supporting decisions with available information;

2. Improving productivity by archiving best practices for future use;

3. Reducing costs by reducing unneeded repetition of research and loss of valuable knowledge;

4. Establishing consistent solutions to reoccurring types of problems by documenting problems and their solutions.

The goal of this survey is to establish the relative weight of the factors that influence KM success. In order to develop a model that measures the success of a KM strategy we need to know the relative influence of these factors on successful KM.

- We want to establish the influence of factors within their field;

- We want to establish the influence of other fields on factors;

- We want to establish the influence of fields on KM success as a whole.

8.1.2 Fields and factors

Successful KM can be supported by various factors. These factors are divided in three different fields:

IT

- Sufficient training of users to use content sharing systems.

- Clarity among all users on what systems are supposed to be used.

- Technical solutions that are in line with the needs of the organization and compatible with existing processes.

- Usage of the same systems by all employees to save and share knowledge.

- Content sharing systems that are easily available.

- Sufficient technical support.

Employees and behavior

- Motivation and commitment of employees towards the KM strategy.

- Sharing of knowledge among employees.

- Cooperation of employees toward a common goal.

- Sufficient documentation of research and projects.

- Sufficient understanding among employees on how to handle knowledge.

- Usage of the available tools to save and share knowledge.

Strategy and organization

- The existence of a clear KM strategy.

- An organizational culture that supports sharing of new knowledge and the usage of existing knowledge.

- Sufficient facilities within the company to come together and share knowledge.

- Cooperation between business units.

- Retainment of experienced staff.

- Accessibility of existing knowledge.

8.1.3 Practical information

We need this information in order to establish whether there are differences in opinion based on departments or functions. Also, we want to establish whether someones experience with KM influences his or her opinion on the subject.

How would you describe your competences and proficiency with regard to knowledge-/content management?

- Fundamental Awareness (basic knowledge)

- Novice (limited experience)

- Intermediate (practical application)

- Advanced (applied theory)

- Expert (recognized authority)

What is your function?

Which company do you work for?

Which department do you work for?

8.1.4 Factors in the field of strategy and organization that influence the successfulness of KM

Please value the following factors on a scale from 1 to 10 based on the positive influence, they have on successful knowledge management

- Availability of existing knowledge.

- The existence of a clear KM strategy.

- An organizational culture that supports sharing of new knowledge and the usage of existing knowledge.

- Retainment of experienced staff.

- Cooperation between business units.

- Sufficient facilities within the company to come together and share knowledge.

8.1.5 Factors in the field of employees and behavior that influence the successfulness of KM

Please value the following factors on a scale from 1 to 10 based on the positive influence, they have on successful knowledge management

- Usage of the available tools to save and share knowledge.

- Sufficient understanding among employees on how to handle knowledge.

- Sharing of knowledge among employees.

- Motivation and commitment of employees towards the KM strategy.

- Sufficient documentation of research and projects.

- Cooperation of employees toward a common goal.

8.1.6 Factors in the field of IT that influence the successfulness of KM

Please value the following factors on a scale from 1 to 10 based on the positive influence, they have on successful knowledge management

- Sufficient training of users to use content sharing systems.

- Clarity among all users on what systems are supposed to be used.

- Technical solutions that are in line with the needs of the organization and compatible with existing processes.

- Content sharing systems that are easily available.

- Usage of the same systems by all employees to save and share knowledge.

- Sufficient technical support.

8.1.7 Influence of other fields on the factors

In the previous questions, you have rated the influence of factors within their respective fields. Now, we will continue with the influence of other fields on those factors.

Please value the following factors on a scale from 1 to 10 based on the influence, IT has on the factors in the field of strategy and organization.

- Availability of existing knowledge.

- The existence of a clear KM strategy.

- An organizational culture that supports sharing of new knowledge and the usage of existing knowledge.

- Retainment of experienced staff.

- Cooperation between business units.

- Sufficient facilities within the company to come together and share knowledge.

Please value the following factors on a scale from 1 to 10 based on the influence, IT has on the factors in the field of employees and behavior.

- Usage of the available tools to save and share knowledge.

- Sufficient understanding among employees on how to handle knowledge

- Sharing of knowledge among employees

- Motivation and commitment of employees towards the KM strategy.

- Sufficient documentation of research and projects.

- Cooperation of employees toward a common goal.

Please value the following factors on a scale from 1 to 10 based on the influence, employees and behavior have on the factors in the field of strategy and organization.

- Availability of existing knowledge.

- The existence of a clear KM strategy.

- An organizational culture that supports sharing of new knowledge and the usage of existing knowledge.

- Retainment of experienced staff.

- Cooperation between business units.

- Sufficient facilities within the company to come together and share knowledge.

Please value the following factors on a scale from 1 to 10 based on the influence, employees and behavior have on the factors in the field of IT.

- Sufficient training of users to use content sharing systems.

- Clarity among all users on what systems are supposed to be used.

- Technical solutions that are in line with the needs of the organization and compatible with existing processes.

- Content sharing systems that are easily available.

- Usage of the same systems by all employees to save and share knowledge.

- Sufficient technical support.

Please value the following factors on a scale from 1 to 10 based on the influence, strategy and organization have on the factors in the field of employees and behavior.

- Usage of the available tools to save and share knowledge.

- Sufficient understanding among employees on how to handle knowledge.

- Sharing of knowledge among employees.

- Motivation and commitment of employees towards the KM strategy.

- Sufficient documentation of research and projects.

- Cooperation of employees toward a common goal.

Please value the following factors on a scale from 1 to 10 based on the influence, strategy and organization have on the factors in the field of IT.

- Sufficient training of users to use content sharing systems.

- Clarity among all users on what systems are supposed to be used.

- Technical solutions that are in line with the needs of the organization and compatible with existing processes.

- Content sharing systems that are easily available.

- Usage of the same systems by all employees to save and share knowledge.

- Sufficient technical support.

8.1.8 Influence of the three fields on KM success

In the previous questions, you have rated the influence of fields on factors in different fields. To conclude the survey we want to establish what fields are the most important for successful knowledge management.

Please value the following fields on a scale from 1 to 10 based on the positive influence, they have on successful knowledge management.

- IT

- Employees and behavior

- Strategy and organization

If you would like to receive information on the results of this survey or if you want to participate in an interview on the subject of knowledge management, you can leave your contact information here. If you do not want to be contacted you may leave these fields empty.

8.2 Extended survey results: cross field influence

Factor	0	1	2	3	4	5	6	7	8	9	10
The existence of a clear KM strategy.	2	0	1	3	3	2	1	3	4	0	0
An organizational culture that supports sharing of new knowledge and the usage of existing knowledge.	5	0	0	2	0	1	1	4	3	2	1
Sufficient facilities within the company to come together and share knowledge.	1	0	0	0	1	1	4	4	3	4	1
Cooperation between business units.	2	0	2	0	0	4	1	6	1	2	1
Retainment of experienced staff.	3	0	1	3	2	3	2	2	3	0	0
Accessibility of existing knowledge.	1	0	0	1	2	0	5	1	5	3	1
total (Strategy and organization)	**14**	**0**	**4**	**9**	**8**	**11**	**14**	**20**	**19**	**11**	**4**
Motivation and commitment of employees towards the KM strategy.	2	1	2	0	2	6	3	0	2	0	1
Sharing of knowledge among employees.	1	1	0	0	1	1	5	7	3	0	0
Cooperation of employees toward a common goal.	1	2	3	2	2	4	3	1	1	0	0
Sufficient documentation of research and projects.	0	0	3	2	1	5	2	0	2	3	1
Sufficient understanding among employees on how to handle knowledge.	1	0	0	3	4	4	1	2	3	0	1
Usage of the available tools to save and share knowledge.	1	0	0	0	1	1	0	3	6	4	3
total (Employees and behavior)	**6**	**4**	**8**	**7**	**11**	**21**	**14**	**13**	**17**	**7**	**6**

Table 10: Number of respondents that gave a score to factors that are influenced by the field of "IT"

Factor	0	1	2	3	4	5	6	7	8	9	10
The existence of a clear KM strategy.	0	1	2	2	1	1	2	1	4	1	4
An organizational culture that supports sharing of new knowledge and the usage of existing knowledge.	0	0	0	1	0	2	1	3	3	3	6
Sufficient facilities within the company to come together and share knowledge.	0	1	1	1	0	3	4	3	2	1	3
Cooperation between business units.	0	0	0	0	0	2	2	3	4	4	4
Retainment of experienced staff.	0	0	0	2	4	0	1	3	4	1	4
Accessibility of existing knowledge.	0	0	0	0	3	2	1	5	4	3	1
total (Strategy and organization)	**0**	**2**	**3**	**6**	**8**	**10**	**11**	**18**	**21**	**13**	**22**
Sufficient training of users to use content sharing systems.	0	1	1	2	0	2	2	4	3	2	2
Clarity among all users on what systems are supposed to be used.	0	0	1	3	0	1	2	3	3	3	3
Technical solutions that are in line with the needs of the organization and compatible with existing processes.	1	1	1	1	2	3	4	0	2	1	3
Usage of the same systems by all employees to save and share knowledge.	0	0	2	1	0	0	3	3	4	1	5
Content sharing systems that are easily available.	2	0	0	2	1	5	4	0	2	2	1
Sufficient technical support.	1	1	3	1	4	3	2	1	3	0	0
total (IT)	**4**	**3**	**8**	**10**	**7**	**14**	**17**	**11**	**17**	**9**	**14**

Table 11: Number of respondents that gave a score to factors that are influenced by the field of "employees and behavior"

Factor	0	1	2	3	4	5	6	7	8	9	10
Motivation and commitment of employees towards the KM strategy.	0	0	0	1	1	0	2	4	3	5	3
Sharing of knowledge among employees.	0	0	0	0	0	1	2	5	5	4	2
Cooperation of employees toward a common goal.	0	0	0	0	0	2	3	3	5	3	3
Sufficient documentation of research and projects.	0	0	1	0	1	4	1	4	6	1	1
Sufficient understanding among employees on how to handle knowledge.	0	0	1	0	3	1	2	5	4	1	2
Usage of the available tools to save and share knowledge.	0	0	1	1	0	2	0	7	3	2	3
total (employees and behavior)	**0**	**0**	**3**	**2**	**5**	**10**	**10**	**28**	**26**	**16**	**14**
Sufficient training of users to use content sharing systems.	0	0	2	0	1	1	1	3	5	5	1
Clarity among all users on what systems are supposed to be used.	0	0	1	0	3	0	1	2	8	1	3
Technical solutions that are in line with the needs of the organization and compatible with existing processes.	0	0	0	1	1	1	2	0	5	3	6
Usage of the same systems by all employees to save and share knowledge.	1	1	1	0	0	1	1	4	4	3	3
Content sharing systems that are easily available.	0	0	1	1	0	2	1	1	5	5	3
Sufficient technical support.	1	1	1	1	0	0	3	4	2	5	1
total (IT)	**2**	**2**	**6**	**3**	**5**	**5**	**9**	**14**	**29**	**22**	**17**

Table 12: Number of respondents that gave a score to factors that are influenced by the field of "strategy and organization"

8.3 The survey that is to be used for gathering model input

Strategy and organization

Please rate the following statements on a 1 (total disagreement) - 10 (total agreement) scale based on whether you agree with the statement.

- A clear KM strategy exist in my organization.

- Our organizational culture that supports sharing of new knowledge and the usage of existing knowledge.

- My organization has sufficient facilities within the company to come together and share knowledge.

- Business units cooperate with each other to prevent double work.

- Experienced staff is retained.

- Existing knowledge is easily available.

Employees and behavior

Please rate the following statements on a 1 (total disagreement) - 10 (total agreement) scale based on whether you agree with the statement.

- Employees are motivated and commitment of employees towards the KM strategy.

- Knowledge is shared among employees.

- Employees are working together toward a common goal.

- Research and projects are sufficiently documented.

- There is sufficient understanding among employees on how to handle knowledge.

- The available tools are used to save and share knowledge.

IT

Please rate the following statements on a 1 (total disagreement) - 10 (total agreement) scale based on whether you agree with the statement.

- Users are sufficiently trained to use content sharing systems.

- it is clear to all users what systems are supposed to be used.

- The technical solutions are in line with the needs of the organization and compatible with existing processes.

- All employees use the same systems to save and share knowledge.

- Content sharing systems are easily available.

- Technical support in my organization is sufficient.

8.4 Running the model on dummy data

8.4.1 Dummy input and actual weights that we use in the model

Table 13 shows how we calculate the factor scores using the median scores of the factors. We used the letters a..j to represent dummy employees. Figure 8 shows the weights that we used in the calculation.

Facor	a	b	c	d	e	f	g	h	i	j	median
The existence of a clear KM strategy.	10	6	8	10	8	7	4	4	6	6	**6,5**
An organizational culture that supports sharing of new knowledge and the usage of existing knowledge.	9	9	6	10	5	4	7	5	9	10	**8**
Sufficient facilities within the company to come together and share knowledge.	5	10	10	9	10	6	9	4	10	9	**9**
Cooperation between business units.	4	10	4	4	9	6	7	10	8	6	**6,5**
Retainment of experienced staff.	5	10	7	5	8	5	6	7	8	7	**7**
Availability of existing knowledge.	4	9	9	8	4	6	8	8	9	4	**8**
Motivation and commitment of employees towards the KM strategy.	4	4	5	6	5	4	7	7	4	7	**5**
Sharing of knowledge among employees.	7	7	5	7	5	5	5	7	7	7	**7**
Cooperation of employees toward a common goal.	4	5	5	4	5	5	7	6	5	6	**5**
Sufficient documentation of research and projects.	7	5	5	5	6	7	7	6	4	5	**5,5**
Sufficient understanding among employees on how to handle knowledge.	7	4	4	4	4	5	5	7	7	7	**5**
Usage of the available tools to save and share knowledge.	5	5	4	6	5	6	4	7	4	4	**5**
Sufficient training of users to use content sharing systems.	1	3	5	7	1	5	5	2	3	1	**3**
Clarity among all users on what systems are supposed to be used.	3	2	7	7	2	4	2	6	7	2	**3,5**
Technical solutions that are in line with the needs of the organisation and compatible with existing processes.	7	5	4	3	7	4	6	7	7	3	**5,5**
Usage of the same systems by all employees to save and share knowledge.	2	5	2	4	2	7	4	5	3	1	**3,5**
Content sharing systems that are easily available.	4	7	6	4	7	10	4	7	5	4	**5,5**
Sufficient technical support.	9	4	10	4	7	7	7	7	4	8	**7**

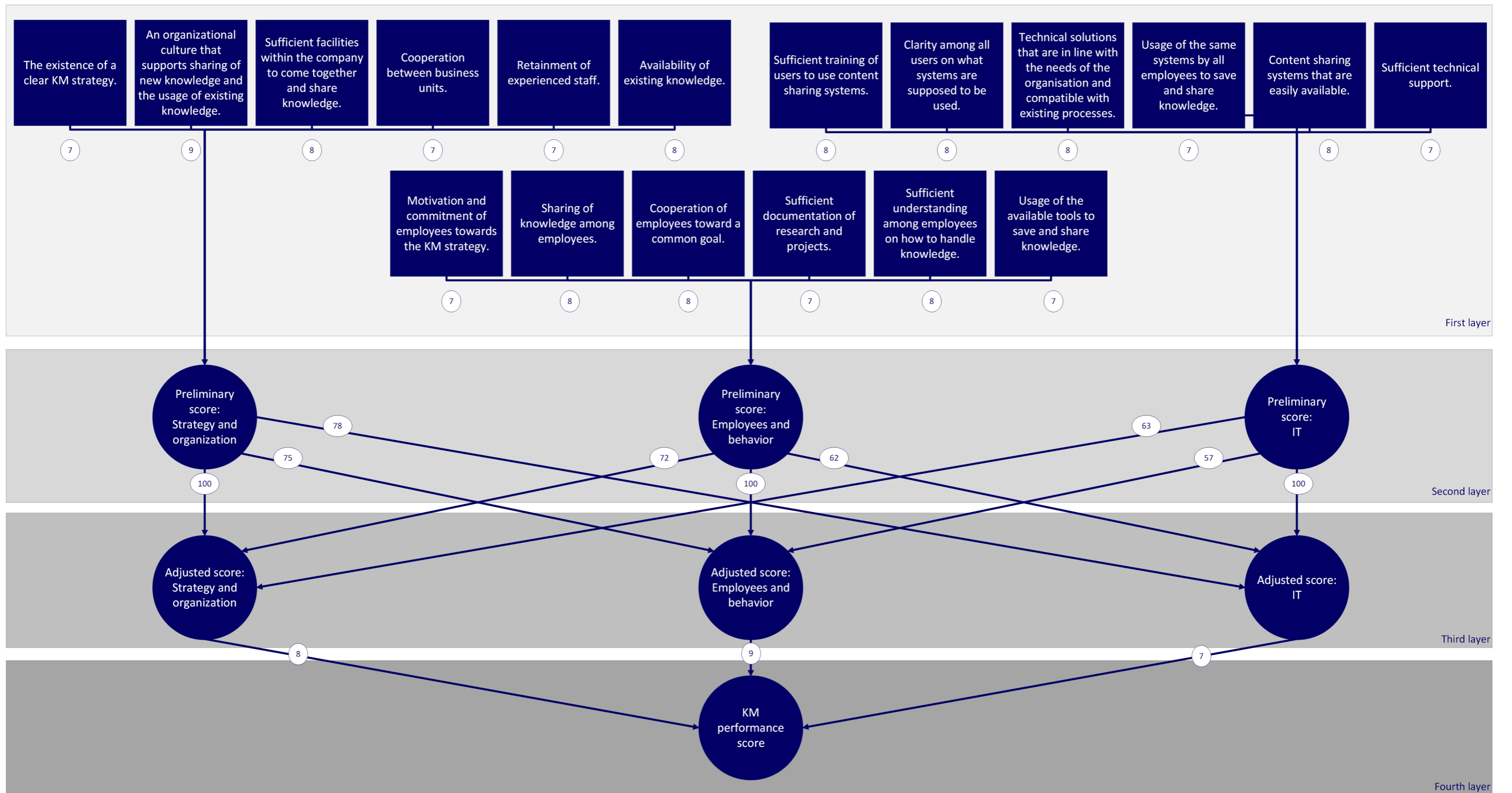Table 13: Generating median factor scores from dummy data

Figure 8: The weights that we use in our calculation

8.4.2 Calculation based on model weights and dummy data

Calculating the initial field scores

Firstly, the initial field score for the field of "strategy and organization" is calculated by taking the weighted average of the first six factors. The weights of these factors

Initial field score: "strategy and organization"
$$(6.5 * 7 + 8 * 9 + 9 * 8 + 6.5 * 7 + 7 * 7 + 8 * 8)/46 = 7.6$$

After that, the initial field score for the field of "employees and behavior" is calculated by taking the weighted average of the second six factors.

Initial field score: "employees and behavior"
$$(5 * 7 + 7 * 8 + 5 * 8 + 5.5 * 7 + 5 * 8 + 5 * 7)/45 = 5.4$$

And finally, The initial field score for the field of "IT" calculated by taking the weighted average of the final six factors.

Initial field score: "IT"
$$(3 * 8 + 3.5 * 8 + 5.5 * 8 + 3.5 * 7 + 5.5 * 8 + 7 * 7)/46 = 4.6$$

Adjusting for cross field influence

The adjusted field scores are calculated by multiplying the initial field scores with the weights we gave them in cross field influence. The direct influence of the initial field score of a factor on the adjusted field score of a factor is 100.

Adjusted field score: "strategy and organization"
$$(7.6 * 100 + 5.4 * 72 + 4.6 * 63)/235 = 6.1$$

Adjusted field score: "employees and behavior"
$$(7.6 * 75 + 5.4 * 100 + 4.6 * 57)/232 = 5.9$$

Adjusted field score: "IT"
$$(7.6 * 78 + 5.4 * 62 + 4.6 * 100)/240 = 5.8$$

Calculating the KM performance score

In order to calculate the KM performance score, we will take a weighted average of the adjusted fields scores.

KM performance score
$$(6.1 * 8 + 5.9 * 9 + 5.8 * 7)/24 = 5.9$$

Interpretation of the results

Overall, we can conclude that this fictitious organization performs reasonable. The KM performance score is 5.9/10 so there is some room for improvement. The initial field scores show that the organization performs well in "strategy and organization" (7.6/10) the performance when it comes to "employees and behavior" is a not as good (5.4/10) and the performance in the field of "IT" is bad with a score of 4.6/10.

The factor scores show that the organization thanks its low score in the field of "IT" mostly to lack of training (3/10), confusion about what systems should be used (3.5/10) and usage of different systems in the organization (3.5/10).

The high score in the field of "strategy and organization" comes from sufficient facilities to come together and share knowledge(9/10), a supporting organizational culture(8/10) and the availability of existing knowledge(8/10).