Managing knowledge

Towards a framework for selecting and implementing a knowledge management strategy for project-based organizations in the construction industry

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Managing knowledge – Towards a framework for selecting and implementing a knowledge management strategy for project-based organizations in the construction industry.

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To provide project-based organizations in the construction industry with a framework for selecting and implementing a knowledge management strategy which can contribute to the improvement of their services, the following research question can be asked for the case of Boskalis:

Under which conditions can a Knowledge Management Strategy help Boskalis to become more successful in the tender phase of projects in the construction industry?

Different methods are used to do research. Existing theories will be described using a literature study. During the field study empirical data will be gathered. Exploratory interviews and internal interviews help to collect data within Boskalis. Also a study is conducted into Boskalis current knowledge management practices and means. Furthermore during the field study employees from other organizations in the construction industry were interviewed. The field study is followed by a design phase. During the design phase, requirement were set for the case of Boskalis. These requirements follow from the literature study and the field study. These requirements were used to make a design for Boskalis which exists of solutions of advices for implementing a knowledge management strategy.

During the literature study, theories were looked into Knowledge, Knowledge Management, Knowledge Management Strategies and Conditions for selecting a Knowledge management strategy. Knowledge is the creation of information, imbedded in the commitments and beliefs of its bearer. Knowledge Management is the systematic and organized process of acquiring, organizing and communicating knowledge. There are three components of knowledge management: People, Processes and Technology. The people component indicates how the organization manages, develops and releases the knowledge and full potential of its people. The process component determines how the organization designs, manages and improves its processes and the technology component includes both hardware and software knowledge management tools.

A Knowledge Management Strategy can help to maintain or improve a knowledge management process. There are two knowledge management strategies; personalization and codification. A personalization strategy focuses on the flow of tacit knowledge through personal contacts while in a codification strategy in codification strategies, explicit knowledge is transferred to information which can be stored in database and can be analyzed independently of the current carriers of the knowledge. Knowledge Management Strategy Conditions can help to determine which knowledge management strategy is best suited for an organization. These (ten) conditions are: Innovation, Networks, Motivation, Attitude, Organization, Community, Sharing, Frequency of repeating tasks, Willingness to follow processes and protocols and the cost-efficiency of a database.

During the literature study not only theories related to knowledge management were explored but also the construction industry was scrutinized. Organizations in the construction industry are characterized by work oriented towards projects. Projects are unique endeavours which are limited in time, scope and resources, and which are outside of the normal organization. These organizations involved in engineering, procuring and building constructions. The procurement consists of a design stage, a tendering stage and a bid evaluation. Tendering is the bidding process of the procurement. There are two award criteria for competitive tendering: Lowest price and most economically advantageous tender (MEAT). For MEAT award criteria more criteria then only the price will be considered. Examples of such award criteria are quality, aesthetic and functional characteristics, environmental characteristics, safety plans, and stakeholder involvement. The bidding process for MEAT award criteria can be explained using the conceptual model for competitive bidding in MEAT. This
model explains how internal and external factors influence the competitive position by differentiation for organizations in the construction industry.

The first stage of the field study consists of giving a presentation of the case study Boskalis. Data gathered during the exploratory interviews and study into the current practices of the organization was used. Boskalis has been in business for over a hundred years and was granted the epithet royal in 2010. Their organizational culture is deeply rooted in operation in the Dutch (and in foreign) construction industries. Their organizational culture can be described as goal oriented, externally driven, with an easy-going work discipline and an orientation towards work. Over time the organization hasn’t lost its local, familiar atmosphere and has a masculine and closed community. However employees indicate an ambition to become a more professional.

Boskalis main activity is dredging and excavation. Based in Rotterdam, Boskalis can organize all activities related to earth movement for the Dutch home market. They do so organized in a number of staff departments, subsidiaries and projects. One of these staff departments is Bebo (Organizational Bureau). The main activity of this department is obtaining projects by participating in tenders.

The Work Instruction Tenders (WIT) provides Boskalis with descriptions for the generic steps that should be completed within a tender process. The WIT is developed for tenders with MEAT award criteria, but it can also be applied for tenders with lowest price award criteria. A tender is successful for the Boskalis when:

1. Boskalis wins the tender
2. For the highest possible bidding price
3. And the highest possible MEAT score
4. As the distance to the price of the number 2 is as small as possible
5. While a realistic price is offered.

The WIT provides internal factors which can influence the company’s position in the bidding process and adds to the success of a tender.

The type of projects Boskalis is involved in require a good understanding and a tailor made product for the client and a good cooperation in partnerships. Boskalis main client is Rijkswaterstaat, other important clients are port authorities, municipalities and water boards. Boka has some long-term partnerships, for instance with organizations Van Oord, Volker Wessels and Heijmans. However, for each project they work in together, a new short term project partnership will be agreed to. Working for and with these other organizations can be challenging due to differences in organizational culture and ways of working.

The internal interviews during the field study helped to gather data on how Boskalis deals with knowledge, knowledge management and knowledge management strategies. The types of knowledge to which Boskalis attaches a great importance are experience and practical knowledge. New employees also divert to explicit to tacit knowledge conversion. Knowledge subjects which are often discussed are technical of nature. Employees care less for discussing ‘the qualitative part’. Qualitative knowledge is for Boskalis all knowledge which is required for the tender phase of a construction project and which is non technical of nature. Despite the differences in how much employees care for discussing the different knowledge subjects, both subjects are important to the organization. All of this knowledge is often available within certain groups, but between different groups, little knowledge is exchanged. Between (sub)departments en between project execution and the tender phase little knowledge is transferred. Furthermore it is difficult for new employees to find the required knowledge and for employees who leave the organization it is difficult to pass on their knowledge.

The current knowledge management process at Boskalis contains a number of activities and means which contribute to the transfer of knowledge within the organization. These activities are ad hoc and not standardized, ranging Boskalis at the initial maturity level of knowledge management. At this level no long-term goals and objectives for the management of knowledge and no allocation of resources for knowledge
management are made. Furthermore there is no clear course for a strategy to manage knowledge within the organization.

During the external interviews from other organizations in the construction industry were asked to give their view on knowledge management within their organizations. For a number of organizations in the construction industry the current situation with regards to knowledge management is similar. They can be ranged in the first two levels of maturity of knowledge management and have no clear long-term planning, set objectives nor a course of action with regards to knowledge management. These organizations are all interested in knowledge management, but don’t know what strategy to select. Two other organizations are on more mature levels of knowledge management and adopt a codification strategy. These organization have been investing for a couple of years in their strategies. Seeking the creation of new knowledge in order to build new competitive advantages, knowledge has been institutionalized in the organization and the scope of knowledge management might even be broadened to the alliances of the organization.

To be able to make a design for a knowledge management strategy for Boskalis, first requirements need to be set. These requirements follow from previous research on literature and internal interviews within Boskalis. The Boskalis interviewees have a preference towards a personalization strategy, with some aspects of a codification. This preference leads to the following requirements for knowledge management within Boskalis:

1. **Requirements for the people component of knowledge management.** A clear determination of innovative and more mature subjects need to made, these require respectively a personalization and a codification approach for knowledge management. The dense social network should be enlarged and be made easier accessible. To do so, management can best, motivate its employees by supporting knowledge management openly, by development of individuals and teams, involving employees in the successes of the organization, making knowledge management activities obligated to attain other outcomes, and creating a rating system for contributed knowledge in a data system. Furthermore, it is important to maintain the easy going and informal atmosphere during at knowledge gatherings. Additionally, it is important for employees to maintain the familiar safe atmosphere while increasing the professionalism of the organization. Finally knowledge management should improve the knowledge transfer between new and experienced employees who are about to leave the organization.

2. **Requirements for the process component of knowledge management.** To improve the effectiveness of knowledge exchanged a determination should be made of which tasks are frequently and which are infrequently repeated. These tasks require respectively a personalization and a codification approach for knowledge management. Also it should be determined which wheels are often reinvented and which interviewees are unaware of these inventions. Furthermore it is important for employees to have loose knowledge management processes with the freedom to make their own choices.

3. **Requirements for the technology component of knowledge management.** In order to make a database effective, a high number of user should be generated, employees have to actively contribute to this database, people should maintain it. It should be made easily accessible, linked to other systems and employees should be given training in the efficient use of such databases.

Most of the other organizations interviewed during the external interviews, indicated a preference towards a personalization strategy. Only one organization indicated a preference towards a codification strategy. The most striking differences between answers from the interviewees in the different organizations occurred for the conditions of willingness to follow processes and cost-efficiency of a database.

A set of short-term, mid-term, long-term and very long-term solutions have been designed in order to achieve the main advice for Boskalis: To implement a personalization strategy towards knowledge management. These solutions can be seen in Table 1.
In the responsibility for knowledge management activities, three important groups can be identified. The employees who are responsible for participating in and give input to the knowledge management activities. The management, who is responsible for supporting and making resources available for the activities and a ‘knowledge manager’ who is responsible for facilitating knowledge management activities within the organization. Without these responsibilities and dedication to knowledge management, no successful implementation of a knowledge management strategy is possible.

When implementing a knowledge management strategy in Boskalis there are five points which will make the difference:

- A long-term dedication to knowledge management
- Setting objectives for knowledge management
- Adopting a personalization course of action
- The allocation of resources
- Management support

Without these five points no successful implementation of a knowledge management strategy is possible within Boskalis.

Finally the solutions have been verified to ensure that the solutions are correct and satisfy all requirements. Also they have been validated to ensure that the correct solutions have been design which helps the department Bebo to ensure continuity of operations through achieving an increased knowledge transfer, a higher average on MEAT scores and more effective communication and collaboration.

Besides helping Boskalis to gain insights in their dealings with knowledge and providing them with an advice to become more successful in knowledge transfer and ensure continuity of operations, the indication of ten conditions for selecting a knowledge management strategy from literature on the people, process and technology aspects of knowledge management provides a theoretical approach for organizations to select a suitable knowledge management strategy and extends the available literature.
ABBREVIATIONS

BAVO = combination of BAM and VOLkerWessel
Bebo = Bedrijfsbureau (organizational bureau)
Cl = Construction Industry
CoP = Community of Practice
DBM = Design, Build and Maintain
D&C = Design and Construct
DoD = Department of Defence
EMAT = Economically Most Advantageous Tender (In Dutch EMVI)
GROW = Goal, Reality, Options, Will
IFR = Injury Frequency Rate
IOR = Inter-Organizational Relationships
K = Knowledge
KAM = Kwaliteit, Arbo & Milieu (Quality, Safety&Health, Environment or SHE-Q)
KM = Knowledge Management
KMC = Knowledge Management Components
KMS = Knowledge Management Strategy
KMSC = Knowledge Management Strategy Conditions
MEAT = Most Economically Advantageous Tender (In Dutch EMVI)
NINA = No Injuries, No Accidents
OC = Organizational Culture
PER = Project End Report
PBO = Project-Based Organization
PUMA = Project Uitvoering Maasvlakte 2 (Project Execution Maasvlakte 2)
RvdR = Ruimte voor de Rivier (space for the river)
RWS = RijksWaterStaat
SE = Systems Engineering
SHE-Q = Safety, Health, Environment, Quality
WIT = Werk Instructie Tenderen (Work Instruction Tenders)
1 INTRODUCTION

The ‘Ruimte voor de Rivier’ (RvdR) projects are initiated by the Dutch government to prevent flooding of major rivers in the Netherlands and to improve the “spatial quality” of the rivers (Ruimte voor de rivier). There are over 30 projects along the Dutch rivers requiring dike relocation, excavation of the river foreland, depolderization, deepening of the summer bed, lowering of the groins and nature and recreational development. Not only the size and the technical aspects of these projects are complex and challenging. But also the stakeholder involvement and control of contract often pose challenges for involved organizations.

An example of such a complex project is the ‘Ruimte voor de Rivier Zwolle’. Then aim of this project is to prevent flooding of the river IJssel near the city of Zwolle and to improve the special quality. Many stakeholders are involved in this project. Inhabitants, water boards, provinces (the river is the border between two provinces), nature organizations and many more.

Tendering is the bidding process of the procurement in a construction project (Scarborough, Swam, Laurent, Bresnen, Edelman, & Newell, 2004). There are two award criteria for competitive tendering; The lowest price and the most economically advantageous tender (MEAT) (Parikka-Alhola, Nissinen, & EKroos, 2006). In many situations when the client is a governmental body and the construction project has a large social impact, the client will select the most economically advantageous tender. For MEAT award criteria not only the price is important, but also award criteria like quality, aesthetic and functional characteristics, environmental characteristics, safety plans, and stakeholder involvement.

The ‘Ruimte voor de Rivier Zwolle’ is such a project which the Dutch government would award to the most economically advantageous tender. A number of contractors put a bid out on this MEAT awarded tender. One of those contractors was the Dutch dredging and excavation organization Boskalis.

Boskalis has a long history in the construction industry and was also familiar with the RvdR-projects. Not long before the tender for RvdR Zwolle, Boskalis won the tender for the RvdR Deventer. Deventer is a city which lies upstream on the river IJssel, as the crow flies about 28 kilometres from Zwolle. Many conditions for these tenders are the same. They’d already had experience with the wishes and demands of the water boards, of the two provinces located along the river IJssel and other stakeholders. Furthermore other environmental, geographical and soil conditions were comparable. However Boskalis did not benefit enough from experience with ‘Ruimte voor de Rivier Deventer’ and lost the ‘Ruimte voor de rivier Zwolle’ tender.

Why did Boskalis not benefit enough in the RvdR Zwolle tender from the experience they gained during the RvdR Deventer tender? The department Bebo (short for organizational bureau) is responsible for obtaining projects by participating in tenders. All though tenders are a phase in the construction project, they can be seen as a project in itself. Tenders for Boskalis Bebo are unique endeavours which are limited in time, scope and money. When one tender is finished, Bebo employees start working on the next tender.

Little time is spend incorporating knowledge or experience from one tender into the next tender. In fact, in 2011, Bebo employees ranked the knowledge transfer within their department on a 5,5 in a ten-point scale. Furthermore the client requirements become more complex. The client requires more than just a technological solution for the lowest price and it becomes more difficult for an organization like Boskalis to assess and satisfy the clients’ demands.
The limitations in time scope and money, combined with the unique character of tenders and the increasing complexity of client requirements require organizations in the construction industry like Boskalis to change their ways of working.

One potential area for considerable improvement in many construction companies is Knowledge Management (KM). Knowledge Management can be defined as the identification, optimisation and active management of intellectual assets to create value, increase productivity, and gain and sustain competitive advantage (Webb, 1998).

There are two types of knowledge; *tacit and explicit knowledge*. Explicit knowledge is easy to codify, while tacit knowledge is implicit and has a personal character (Nonaka, 1994). Managing knowledge is managing the transfer of knowledge over the boundaries of an organization (Alavi & Leidner, 1999). When an organization is a project-based organization, there are extra organizational boundaries which inhibit knowledge sharing between the different parts of the organization. These boundaries have to do with the uniqueness of projects and its location outside the mainstream organization (Prencipe & Tell, 2001). If an organization’s main strategy of Knowledge Management focuses on the transfer of tacit knowledge between professionals, this is called a *personalization strategy* (Gammelgaard, 2007), while when the focus lies on the distribution of explicit knowledge in an organization through tools and databases, this is called a *codification strategy* (Prencipe & Tell, 2001).

Most scientific research on knowledge management focuses on codification of explicit knowledge and less to the transfer of tacit knowledge. Also there is no approach on how a company should determine which strategy is suitable for their organization and how this strategy should be implemented.

### 1.1 Research Objective and Research Question

The gap of literature to determine what sort of knowledge management strategy to select and the case of Boskalis, a project based organization in the construction industry lead to the following research objective and questions:

The main research objective of this thesis is

To provide project-based organizations in the construction industry with a framework for selecting and implementing a knowledge management strategy which can contribute to the improvement of their services.

The main research question is

**Under which conditions can a Knowledge Management Strategy help Boskalis to become more successful in the tender phase of projects in the construction industry?**

This research is divided in four main sub-questions which are listed below

1. What are theories on knowledge management?
   a. What is knowledge management?
   b. What are knowledge management strategies for project-based organizations?
   c. What are conditions for selecting a knowledge management strategy?
   d. What is the role of project-based organizations in the construction industry?
2. What is the current situation of knowledge management at project-based organizations in the construction industry?
   a. What are the characteristics in the case of Boskalis: a project-based organization in the Dutch construction industry?
   b. What is a successful tender phase?
   c. What are elements of the current knowledge management process at Boskalis?
   d. What is the current situation in other project-based organizations in the Dutch construction industry?

3. How can a design be made a knowledge management strategy for the case?
   a. What are requirements for a knowledge management strategy for Boskalis?
   b. What strategy should Boskalis deploy?
   c. How should this be implemented at Boskalis?

4. What is the generic application of knowledge management for PBO’s in the construction industry?
   a. Which aspects are of value to the industry?

1.2 The thesis outline

In chapter 2 will be explained what theories exist on knowledge, knowledge management, knowledge management strategies, conditions for choosing a knowledge management strategy and on characteristics of the construction industry.

In chapter 3 will be explained what methods are used to do research. In existing theories will be determined using a literature study, other data will be gathered using interviews with Boskalis employees, but also with employees from other organizations in the construction industry. These interviews will be used to form the empirical basis of the research.

Next, characteristics of the case, Boskalis, and its role in the construction industry will be explained. Its history, organizational culture, types of projects, methods of tendering and inter-organizational relationships will be illustrated.

In chapter 5 will be discussed how Boskalis currently deals with knowledge, knowledge management, and knowledge management. Theories determined during the literature study will be tested for the case of Boskalis through interviews.

The current situation is followed by requirements for a desired situation. Using ten conditions for choosing a knowledge management strategy a course which would be most effective for Boskalis is determined and requirements are distilled, which a knowledge management design should satisfy.

These solutions for implementing a knowledge management strategy will be presented in chapter 7. Furthermore responsibilities will be determined in this chapter and the solutions will be verified and validated.

Finally a conclusion, reflection and recommendations for this research will be presented in the last chapter.
2 Theory

2.1 Introduction

This chapter will be the theoretical basis for the research. In it the existing theories on knowledge, knowledge management and knowledge management strategies will be presented. Conditions which can help to choose a knowledge management strategy for your organization have not been sufficiently presented in the existing literature. These will be elaborated with theories on the three knowledge management components: People, processes and technologies.

Knowledge, knowledge management, knowledge management strategies and conditions for knowledge management strategies are relevant for any type of organization in any industry. This research however focuses on project-based organizations in the tender-phase of the construction industry. To be able to get a better understanding of organizations in this industry, some existing theories on characteristics of such organizations in this industry will be presented.

In Figure 1, a schematization of the set-up of this chapter can be seen. First will be explained what knowledge is and what types of knowledge exist (K). Next will be explained what knowledge management, what the maturity levels of knowledge management are and the three knowledge management components will also be explained (KM). In the following chapter the two knowledge management strategies, codification and personalization, will be explained (KMS). After this the elaborated conditions for choosing a knowledge management strategy will be explained (KMSC). Next will be explained how projects are relevant for the construction industry (PBO). Special attention will be paid to the tender phase (T) of a construction project. Furthermore will be explained how organizations operating under such circumstances are organized. Next, inter-organizational relationships (IOR) and how such relationships influence organizations in the construction industry, will be explained. This chapter ends with a conclusion and an answer to the first research question.

2.2 Knowledge

"Knowledge is the endless pursuit of truth, goodness and beauty" (Nonaka, A dynamic theory of organizational knowledge creation, 1994). To understand this endless pursuit of truth, goodness and beauty, first an explanation of the concepts of data and information will be given. Data are uninterrupted symbols (van der
Spek & Spijkervet, 2005), which results in information when it is interpreted and supplemented with a meaning (de Bruijn, 2010). Knowledge can be considered as the creation of information, imbedded in the commitments and beliefs of its bearer (Nonaka, A dynamic theory of organizational knowledge creation, 1994) or as information made actionable (Alavi & Leidner, 1999). Knowledge transfer in project-based organizations is the process through which one unit is affected by the experience of another (Argote & Ingram, 2000).

Learning is adapting, enlarging and deepening your knowledge (van der Spek & Spijkervet, 2005). Organizational learning occurs when an organization is able to adapt, enlarge, and deepen its knowledge and to detect and correct error, as well as reflecting this new gained knowledge and insights by adapting its behaviour (von Zedtwitz, 2002). Since projects are often outside the mainstream of organizational structures project based learning is the creation and acquisition of knowledge within projects as well as transfer of this knowledge to other parts of the organization or to other projects. (Scarborough, Swann, Laurent, Bresnen, Edelman, & Newell, 2004).

2.2.1 TYPES OF KNOWLEDGE

To understand how an organization can learn, a further elaboration on the types of knowledge which can be adapted, enlarged and deepened, needs to be presented. The creation of knowledge can be explained using two types of knowledge: tacit and explicit knowledge. (Nonaka, A dynamic theory of organizational knowledge creation, 1994). Tacit knowledge is implicit knowledge with a personal quality (Nonaka, A dynamic theory of organizational knowledge creation, 1994). Tacit knowledge is hard to codify and many knowledge professionals own is of this type (de Bruijn, 2010). People might not even be aware of the value of this knowledge to others. Explicit knowledge is knowledge which is transmittable to others and is easy to codify (Nonaka, A dynamic theory of organizational knowledge creation, 1994).

Knowing these two types of knowledge, knowledge can be created by knowledge conversion (Nonaka, A dynamic theory of organizational knowledge creation, 1994). The four modes of knowledge creation can be seen in Figure 2. First knowledge conversion can occur from tacit knowledge to tacit knowledge, which is called socialization. This form of knowledge creation occurs when people share experiences. This socialization is connected with organizational culture. Second, knowledge can be converted from tacit to explicit knowledge, which is defined as externalization. This occurs when creating manuals or translating results into recommendations for a practice. Thirdly, knowledge can be converted from explicit to tacit knowledge, which is called internalization. Internalization has similarities to (organizational) learning. Finally, combination is conversion from explicit to explicit knowledge for instance through information processing and combining documents.

2.3 KNOWLEDGE MANAGEMENT

Knowledge management (KM) aims at providing instruments to optimize this knowledge creation process in organizations (van der Spek & Spijkervet, 2005). Knowledge management is the systematic and organized process of acquiring, organizing and communicating tacit and explicit knowledge (Alavi & Leidner, 1999) in order to create new knowledge, to distribute knowledge to people who require it, to make knowledge accessible for future use, to combine knowledge areas and to make knowledge collectively accessible (van der Spek & Spijkervet, 2005).
2.3.1 MATURITY OF KNOWLEDGE MANAGEMENT ACTIVITIES

When knowledge management activities in organizations are scrutinized, first an assessment must be made of the degree of the maturity level of knowledge activities in an organization. There are different ways to determine this maturity level. For instance Van der Spek & Spijkervet (2005) determine the maturity on basis of how the knowledge is applied within the organization. A more suitable determination of the maturity is given by von Zedwitz (2002) and Klimko (2001). They give an assessment method of the maturity level of the institutionalization of the knowledge management process. This five-level maturity model consists of the initial level, the knowledge discovery level, the knowledge creation level, the knowledge management level and the knowledge renewal level:

1. **Initial level**. At this level the organization is working without paying any specific attention to knowledge management activities. Knowledge management is chaotic, ad hoc and not standardized.
2. **Knowledge discovery level**. At this level the organization is aware of the importance of its existing knowledge but still considers it as a form of information management. The knowledge management process is established in guidelines and is repeatable and comparable.
3. **Knowledge creation level**. At this level the organization is seeking the creation of new knowledge on order to build new competitive advantages. The primary focus is on finding the required new knowledge that serves the interest of future business. The knowledge is documented, standardized and integrated in the project management process.
4. **Knowledge manager level**. At this level knowledge is institutionalized in the organization. There are individuals and/or organizational units dedicated to knowledge management. The organization sets measurable quantitative goals which lead to corrective action on the knowledge management process and the process controls and all these knowledge processes are established organization wide.
5. **Knowledge renewal level**. At this level the scope of knowledge management is broadened to the alliances of the organization.

2.3.2 KNOWLEDGE MANAGEMENT COMPONENTS

When the maturity level of an organization has been determined and the organization wants to improve or maintain their maturity level in knowledge management, it is important to address the three knowledge management components – People, Process and Technology – and not focus on any one element (Bhatt, 2000). Many companies fail to successfully implement knowledge management as they see knowledge management as a technical implementation. For instance they create an intranet but do not pay any attention to the people or process components. The reason for this is probably because the technology component is the easiest and quickest to implement, while people and cultural issues are much harder to change. However, knowledge management will yield maximum benefits when all components are addressed. In Figure 3 the three knowledge management components and sub-elements can be seen. These components people, processes and technology will further be explained in the following paragraphs.
2.3.3 PEOPLE

The knowledge management component people indicates how the organization manages, develops and releases the knowledge and full potential of its people at an individual, team-based and organization-wide level, and plans these activities in order to support its policy and strategy and the effective operation of its processes (Bhatt, 2000). The people are the human components of an organization (Argote & Ingram, 2000). The development issues related to this people component will probably require the most effort when developing knowledge management in an organization. However, this element is necessary to develop for only then true benefits will be realized (Bhatt, 2000). The people within an organization make knowledge management processes and technologies happen. Some sub-elements of this knowledge management component are attitude, sharing, innovation, motivation, organization and communities.

Organizational culture

People-development issues are largely cultural (Bhatt, 2000). Therefore some special attention will be paid to cultures within organizations. Besides Bhatt more literature indicated the importance of organizational culture in knowledge management.

“The culture of the organization is both the consequence of the organization’s prior experience and learning, and the basis for its continuing capacity to learn.” (Schein, 1996). Organizational culture and learning are intimately linked, and changes in the way an organization creates, transfers and applies knowledge are almost impossible without changing and adapting the knowledge management strategies to fit the organizational culture (Long, 1997).

To characterize this organizational culture a number of features have been determined by Hofstede et al. (1990): Organizational culture is holistic, it is historically determined, it is related to anthropological concepts, it is socially constructed, it is soft and it is difficult to change. A cultural organizational model consisting of a number of autonomous dimensions (Hofstede & Waisfisz) can help to characterize organizational culture and can help to indicate cultural inhibitions to knowledge sharing. Six dimensions of organizational culture will be explained, being: (1) Means vs. Goal oriented, (2) Internally vs. Externally driven, (3) Easy going vs. Strict going to work principle, (4) Local vs. Professional, (5) Open vs. Closed system and (6) Employee vs. Work oriented.

A means oriented culture is an organizational culture where employees feel that “how” the work is done is most important. This in contrast to a goal oriented culture where “what” work is done is of importance to employees. In this last extreme of this organization culture dimension, employees are striving to reach a certain goal or result, even if this involves taking some risks. In a means oriented culture, employees are concerned with the way they do their work every day and avoiding risk.

The dimension of internally vs. externally driven culture tends to how employees see the world and which markets they operate in. An internally driven organization often operates in a market where a monopoly exists. Employees in such an organizational culture are very concerned with business ethics and honesty. In competitive markets often organizations with an externally driven culture operate which focus on meeting customer requirements and are more pragmatic in ethical matters.

The easy vs. strict going to work dimension has a correlation with the products and organization produces. If the products or services are more risky or require precision work, the organizational culture tends to be stricter going to work oriented. When an organization is involved with more innovative and unpredictable activities are often more easy going. There is little control and discipline, whereas in strict culture employees are very serious and punctual.

Local organizations are often smaller, flat organizations where employees identify with their department. Professional organizations are usually larger organizations where there’s a lot of cooperation and trust between departments.
The dimension of an open system vs. a closed system is closely correlated to the national culture. Dutch organizations have the tendency to be more closed than for instance Danish organizations. Also the openness of an organization can be indicated by the percentage woman employed and the seniority of employees.

Finally, the employee vs. work oriented dimension reflects the management philosophy. For instance if an organization is operating against profits in a market (external standards) it is a more work oriented culture, and when it is operating against a budget (internal standards) in is a more employee oriented organization.

2.3.4 PROCESSES
The second knowledge management component determines how the organization designs, manages and improves its processes in order to support its policy and strategy and fully satisfy, and generate increasing value for, its customers and other stakeholders (Bhatt, 2000). Processes reflect the organization’s goals, intentions, and purposes (Argote & Ingram, 2000). Processes should follow standard practices and procedures. For knowledge management to be successful it is important to determine what practices and procedures are standard and how eager employees are to follow standardized practices and procedures. The processes in an organization help the people to make optimum use of the available technologies.

2.3.5 TECHNOLOGY
The last component of knowledge management is technology. The technology component includes both hardware and software knowledge management tools (Argote & Ingram, 2000). This component is probably the quickest and easiest to implement and therefore in many organizations the only component to be implemented (Bhatt, 2000). However without people using these technologies or processes making technologies easy to use, implementing this component will not lead to effective knowledge transfers. Actually only 10% of the issues related to implementing knowledge management in an organization relate to the technology component (Bhatt D., 2000). More issues occur with the process component (20%) and the people component (70%). A holistic approach is need for implementation of all knowledge management elements.

2.4 KNOWLEDGE MANAGEMENT STRATEGIES
A corporate strategy is the determination of long-term goals and objectives of an organization, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals (Caves, 1980). A strategy oriented towards knowledge management can help maintain or improve a knowledge management process. After determining the maturity of the knowledge management activities, and indicating a need for maintaining or improving the knowledge management activities; a strategies can be chosen to improve or maintain the knowledge management process. Most companies like to manage their knowledge process use a personalization or a codification strategy (Gammelgaard, 2007). Often companies implement some aspects of both strategies but emphasize one strategy. (Hansen, Nohria, & Tierney, 1999).

2.4.1 PERSONALIZATION STRATEGY
A personalization strategy focuses on the flow of tacit knowledge through personal contacts (Gammelgaard, 2007) and the improvement of a professional organization based on criteria of human behaviour and the cultural context thereof. Knowledge here is inseparable from a person (van der Spek & Spijkervet, 2005).

When reviewing the three knowledge management components, this strategy puts more emphasis on the people component. The focus on knowledge transfer through personal contacts, human behaviour and the cultural context are elements of the people component. The process and technology component in the personalization industry help to support the people component.
2.4.2 CODIFICATION STRATEGY

In codification strategies, explicit knowledge is transferred to information (Prencipe & Tell, 2001) which can be stored in database and made accessible to all company personnel (Gammelgaard, 2007). Such systems which facilitate codification of organizational knowledge, collection, storage, verification and dissemination are called Knowledge Management Systems (KMS) (Alavi & Leidner, 1999). In this strategy, knowledge is regarded as a production factor that can be analyzed independently of the current carriers of the knowledge (van der Spek & Spijkervet, 2005).

When applying a codification strategy emphasis is put on the technology component. The people and processes components help to support the technology component. Systems which facilitate codification, collection, storage, verification and dissemination of organizational knowledge are elements of the technology component.

2.5 KNOWLEDGE MANAGEMENT STRATEGY CONDITIONS

The necessity of addressing all three components; even when emphasis is put on one component; supports Hansen, Nohria & Tierney’s (1999) claim that organizations often implement some aspects of both strategies. However there still is a necessity to make distinction between the two strategies. For knowledge management to be effective it is important to reflect an organization. There are some different conditions under which one strategy is more effective than the other.

Hansen, Nohria & Tierney (1999) and Boh (2003) determined five Knowledge Management Strategy Conditions for which can help to determine the most effective strategy. These are innovation, networks, sharing, frequency of repeating tasks and cost-efficiency of a database. More theories on people, processes and technologies have been reviewed in order to have a more holistic approach for conditions to select a knowledge management strategy. This in order for all components to be integrated into the knowledge management strategy.

Together with the conditions determined by Hansen, Nohria & Thierney and Boh, and the conditions taken from theories on organizational culture and knowledge dimensions, a total of ten conditions are determined for choosing the most suitable knowledge management strategy for an organization. These ten conditions are: Innovation, Networks, Motivation, Attitude, Organization, Community, Sharing, Frequency of repeating tasks, Willingness to follow process and protocols and the Cost-efficiency of a database. In the following paragraphs these conditions will be explained. Also will be described how they can contribute to determining the most suitable knowledge management strategy for an organization. An overview of these conditions and the reason why to choose for one strategy or the other can be seen in Table 2.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Personalization</th>
<th>Codification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Innovation</td>
<td>Innovative product</td>
<td>Mature product</td>
</tr>
<tr>
<td>2. Networks</td>
<td>Informal, dense social network</td>
<td>Formal network of databases</td>
</tr>
<tr>
<td>3. Motivation</td>
<td>Improved rep organization &amp; personal development</td>
<td>Being respected as expert by colleagues</td>
</tr>
<tr>
<td>4. Attitude</td>
<td>Easy going work discipline</td>
<td>Strict work discipline</td>
</tr>
<tr>
<td>5. Organization</td>
<td>Local, flat organization</td>
<td>Professional, layered organization</td>
</tr>
<tr>
<td>6. Community</td>
<td>Open system</td>
<td>Closed system</td>
</tr>
<tr>
<td>7. Sharing</td>
<td>Ambiguous, tacit knowledge</td>
<td>Explicit knowledge</td>
</tr>
<tr>
<td>8. Frequency of repeating tasks</td>
<td>Infrequent repetition</td>
<td>Frequent repetition</td>
</tr>
<tr>
<td>9. Willingness to follow</td>
<td>Goal oriented</td>
<td>Means oriented</td>
</tr>
</tbody>
</table>
These ten conditions are organized according to the knowledge management components, people and culture, processes and technology.

## 2.5.1 People

### Innovation

Innovation. The first condition is the business strategy an organization has on the innovation of their product (Hansen, et al., 1999). The more innovative the product is an organization creates, the more effective a personalization strategy will be for an organization. An innovation is *'The effort to create purposeful, focused change in an enterprise's economical or social potential'* (Drucker, 1998). Innovation of its products helps an organization to cope with competition in a changing market place (Su, Chen, & Sha, 2006). As result of the dialogue between people in a personalization strategy, jointly a deeper insight can be achieved (Sanchez, 2006). When a product is more mature and the organization is more familiar with the product, then an organization benefits more from a codification strategy.

### Networks

Networks. The second condition is the role a network plays in the transfer of knowledge (Boh, 2003). If employees have a dense social network through which they easily share personal information in an informal way and are also able to approach the knowledge-carrier, the organization can best choose a personalization strategy. If databases are linked in a network and employees feel at ease to access and search for knowledge; for such organizations, a codification strategy is more appropriate.

### Motivation

Motivation. Employees who are motivated by an improved reputation of the organization and personal development do better with a personalization strategy (Gammelgaard, 2007). These two stimuli lead to a self-reinforcing process, which also may be useful for the future transfer of knowledge. If the employees in an organization are best motivated by being respected as an expert by colleagues, than such an organization can better choose a codification strategy. In such a case, your colleagues can score your contributions to a data system and you can directly see and measure how much your colleagues can appreciate your expertise.

### Attitude

Attitude. When an organization has an easy going work discipline with an informal attitude, than there is little control and discipline. The informal, personal way of gathering knowledge of the personalization strategy will be better suited to the organization. When an organization has a strict work discipline with a formal attitude, employees will be very serious and punctual. In such a situation the formal, strict way of gathering knowledge of the codification strategy is more appropriate.

### Organization

Organization. When the organizational culture can be described as a local organization with a flat organizational structure, a personalization strategy can better be applied. In a local, flat organization employees identify with their own departments (Hofstede, et al., 1990). Within such departments employees are aware who has such knowledge and this knowledge is timely accessible. Other employees are willing to help colleagues and there is enough familiarity and safety within the department to ask for help (Cross, et al., 2001). When the organizational culture can be characterized as professional and layered a codification strategy can better be applied. In such organizational cultures there is more collaboration and trust between departments. However, it is difficult to find out on the short term who has what knowledge, and to access this person’s knowledge. Also it is difficult to get this person to engage in knowledge sharing and to become
familiar with such a person in a short time span in order to create safe feeling necessary to ask critical questions. In such a situation it is better to search for codified, explicit knowledge.

Community
Community. In a community with an open system, employees are easily able to open themselves up and to put themselves in a vulnerable position (Hofstede, et al., 1990). In such an organization, it is also easier for employees ask for help from colleagues and they feel comfortable with a personalization strategy. In a community with a closed system employees are less able to put themselves in a vulnerable position. Employees of such an organization will prefer to first try to resolve their problems themselves. They will prefer to first seek documented information. A codification strategy can offer them such information.

Sharing
Sharing. The seventh condition depends on what type of knowledge people rather search for, share and how this knowledge is carried. Some people would rather seek tacit and ambiguous knowledge, which is difficult to separate from the person who carries it (Sanchez, 2006). Such people feel that it is impossible to detach such knowledge from its carrier. Besides they feel that it pays more to share this kind of knowledge. The ambiguity of this knowledge requires dialogue and interaction in order to reduce the ambiguity. This can lead to the development of new insights and the creation of new knowledge. Such employees will feel more comfortable applying a personalization strategy (Boh, 2003), (Hansen, et al., 1999). Other people prefer to search for explicit, codified knowledge, and who feel that this kind of knowledge is clearer. They can better appreciate that this kind of knowledge is explicit and unambiguous and is not tied to a personal knowledge carrier. These employees will feel more comfortable with a codification strategy.

2.5.2 Processes
Frequency of repeating tasks
Frequency of repeating tasks. The eight condition is the product type an organization creates. HNT (1999) argue that organizations which create standardized products can best apply a codification strategy. And organization which follows a customized product approach can best select a personalization strategy. Since a project is an unique undertaking, the end result is a customized product. So in this line of reasoning a project-based organization should choose a personalization strategy. However, Boh (2003) states that for organizations which produce standardized products should choose a personalization mechanism, but for organizations which create customized products the choice of a personalization or codification strategy depends on the frequency of repetition of tasks within a project-based organization. The more frequently tasks are repeated within a project-based organization, the more effective a codification strategy will be for this organization.

Willingness to follow processes
Willingness to follow processes and protocols. When an organization can be characterized as goal oriented it is important what work is done (Hofstede, et al., 1990). It is even allowed to take some risks for the purpose of reaching this goal. The way this goal is reached is of less importance in such organizations. Employees feel comfortable diverting from protocols and taking risks. Therefore they won’t be very interested or willing to strictly follow protocol, nor to document and standardize knowledge. In such an organization a personalization strategy is more applicable. A means oriented organization the way work is done is more important and so is avoiding risks. Employees in such an organization will be more willing to follow protocol and will benefit more from a codification strategy.
2.5.3 TECHNOLOGY

Cost-efficiency of a database

Cost-efficiency of a database. This last condition is the cost-effectiveness of a database. When an organization does not have the resources and users do not are not able to contribute in such a way to a database to ensure that it is up-to-date and it is easy to search in and access the database, an organization can best chose an personalization strategy (Boh, 2003). When an organization is able to achieve a critical mass of users. To have these users contribute their knowledge to this database and to maintain a database, a codification strategy is the most effective strategy.

2.5.4 CONCLUSION ON KMSC

Knowledge is the creation of information, imbedded in the commitments and beliefs of its bearer. Knowledge Management is the systematic and organized process of acquiring, organizing and communicating knowledge. A Knowledge Management Strategy can help to maintain or improve a knowledge management process. And Knowledge Management Strategy Conditions can help to determine which knowledge management strategy is best suited for an organization. These (ten) conditions are: Innovation, Networks, Motivation, Attitude, Organization, Community, Sharing, Frequency of repeating tasks, Willingness to follow processes and protocols and the cost-efficiency of a database.

2.6 THE CONSTRUCTION INDUSTRY

A construction is all that is reducible joint together from two or more elements; a coherent whole which meets predetermined requirements (Hartsuijker, 2001). Examples of constructions in the construction industry are hydraulic structures, buildings, infrastructure and offshore structures.

Organizations in the construction industry are characterized by work oriented towards projects (Keegan & Turner, 2000). These construction projects are at a basic level involved in the planning and building of some physical facility (Pinto & Covin, 1989). Project-based organizations in the construction industry are often involved in large projects over which they exercise little direct control (Hobday, 2000). Other characterizations of this complex project-based industry are the uniqueness of the geographic situation of the construction projects, the ad hoc problem solving, the laggard reaction to adopting innovation, the procurement methods to receive assignments (Bosch-Sijtsema & Postma, 2006) and the long life-cycles of a project (Prencipe & Tell, 2001).

Some features of project-based organizations in the construction industry are (Keegan & Turner, 2000):

- Multi-disciplinary teamwork
- Continuous and discontinuous change
- Enhanced networking with customers and suppliers
- Customer orientation
- Multi-disciplinary and cross functional cooperation
- Very little emphasis in issues such as organizational structure

The construction industry consists of all organizations involved in engineering, procuring and building constructions (Keegan & Turner, 2000). A lot of emphasis for the project-based organizations is on the clients who commission these projects. A lot of work is still done for the government, or through agencies that are spending considerable public money (Keegan & Turner, 2000).

To further characterize this industry, first some more will be explained on project-based organizations. Next the importance of the tender phase for project-based organizations in the construction industry will be
explained and finally more will be explained about why project-based organizations in the construction industry put such an emphasis towards their organizational relationships.

2.6.1 PROJECTS

Projects are an enterprise which makes it for an organization hard to transfer knowledge. Projects are unique endeavours which are limited in time, scope and resources, and which are outside of the normal organization structure but have interaction with other projects within the company because scarcity of resources (Meredith & Mantel, 2010). Each project has some quasi-genetic traits which can be inherited from project to project. These traits reflect the capabilities and routines of an organization (Prencipe & Tell, 2001). Pure forms of project organization structures are organized around projects (Prencipe & Tell, 2001). A project-based organization is engaged in project work, deliver to clients customized specifications while working in (multi-disciplinary) teams to achieve their goals (Keegan & Turner, 2000).

Organizational structure

Different projects have different needs for project teams (Meredith & Mantel, 2010), therefore, for every project the organization of the project team is differently organized. This team organization depends mainly on the functions required in a project. A work breakdown structure can help determine the functions needed in a project. The project manager is responsible for successful project completion and for negotiation between department heads and employees in order to get the required functions filled. An example of a project organization can be seen in Figure 4.

Some organizations are not solely organized around projects, but are also organized around the quasi-generic traits. A matrix structure is an organizational structure which is organized per function and per project as can be seen in Figure 5 (Meredith & Mantel, 2010). An advantage of this organization type is that knowledge can easily be exchange over across task boundaries and it allows specialized functions to exchange knowledge over different projects (Prencipe & Tell, 2001). Project-based organizations often use a matrix structure. This organizational form can bridge the gap between projects and functional areas and contribute to multi-disciplinary project teams (Keegan & Turner, 2000).

An opposite type to the pure project organization is the functional organization. A functional organization is organized solely by function (Meredith & Mantel, 2010).

The holographic organization is an emergent phenomenon (Keegan & Turner, 2000). Such an organization has the ability to self-organize and regenerate itself on a continuous basis. Many project-based organizations in the construction industry put little emphasis on issues such as organizational structure and can have some aspects of self-organization.

Project phasing

For better management and to share responsibility, organizations subdivide projects in a number of manageable phases. General project phases are the project start, project execution and project end (Verbraeck, 2010). Before the project execution, the construction project should be designed and put out to tender by the client in order to select the best contractor to execute the project. The tender phase to receive
the construction assignment can be seen as a project in itself as it is a unique endeavours which is limited in time, scope and resources.

2.6.2 TENDER PHASE

Tendering is the bidding process of the procurement. For a contractor, the goal of a tender is to win the work and to determine the specifications and price of the construction project (Scarborough, Swam, Laurent, Bresnen, Edelman, & Newell, 2004). The procurement consists of a design stage, a tendering stage and a bid evaluation (Eriksson & Westerberg, 2011).

- During the design stage the product is specified. The level of detail depends on the contract type.
- During the tender phase, the tender type depends on the client. Private clients often have a pre-qualification before submitting a bid, whereas public clients are often required to do competitive tendering.
- During the bid evaluation the most capable contractor is selected.

Award criteria for competitive tendering

Private clients are subject to less regulations than a public client is and can determine their own pre-qualification and award criteria. Public clients are often required to competitive tendering to make sure that every bidder has equal chances and the best bidder is chosen. In Europe, governmental parties are required to do a public tender for every project over five million Euros (Chao-Duivis, Koning, & Bruggeman, 2010). For competitive tenders there are two award criteria: The lowest price and the most economically advantageous tender (Parikka-Alhola, Nissinen, & Ekroos, 2006).

For the first selection criterion, the lowest price, the contract will be rewarded to the tender with the lowest price. For the second criterion, the Most Economically Advantageous Tender (MEAT) or Economically Most Advantageous Tender (EMAT), more criteria then only the price will be considered (Parikka-Alhola, Nissinen, & Ekroos, 2006). Such award criteria are for example quality, technical merit, aesthetic and functional characteristics, environmental characteristics, safety plans, stakeholder involvement, running costs, cost-effectiveness, after-sales service and technical assistance, planning, delivery date and delivery period or period of completion. The bid or proposal contains all plans to ensure the above conditions as well as the bidding price.

Conceptual model of competitive bidding in MEAT

The tender procedures for contractors in the construction industry are complex, uncertain and costly (Perng, Juan, & Chien, 2006). Especially when the most economically advantageous tender is the award criterion. For the lowest price a contractor has to do a cost estimation, to estimate the price of the work; but for a MEAT the competitive strategies change.

A model of competitive bidding in MEAT can be seen in Figure 6. This model explains competitive bidding process MEAT. In this figure two
groups of factors can be seen which influence the bidding process for contractors in the construction industry. The first are the external factors. These factors influence the bidding process from outside of the organization. For instance bidding risks, bid related risks and the numbers of bidders. The organization cannot influence these factors. The second are the internal factors. These are factors related and to the organization. Such factors are for instance expertise, experience, resources and capabilities.

These two factors affect the two dimensions of competitive bidding in MEAT, being the bidding price and the company’s position. The bidding price consists of all costs involved in preparing the bid, the actual construction costs and strategic costs. Strategic costs are the costs to enhance the probability of winning a bid. The company’s position in the bidding process is the experience and expertise it has to bring and its business performance. The two dimensions form a competitive position by differentiation. Through an optimization of costs and value a higher probability of winning can be gained.

2.6.3 INTER-ORGANIZATIONAL RELATIONSHIPS IN THE CONSTRUCTION INDUSTRY

Key in the tender process is to try to understand the clients’ wishes and to meet those as closely as possible in your bid. Because projects in the construction industry are often large and complex projects (Hobday, 2000) with long life-cycles (Prencipe & Tell, 2001) and multi-disciplinary teamwork and cross functional cooperation (Keegan & Turner, 2000), often more organizations and different disciplines are involved in one single project. These project alliance start their cooperation in the tender phase.

How the market relationships are relevant for the tender phase and why project-based organizations in the construction industry put such an emphasis towards these relationships will be explained in this section.

Client
Project-based organizations in the construction industry often receive their assignments from governmental bodies after procurement (Keegan & Turner, 2000). Because of the public character of this main client, project-based organizations often subject to political fluctuations, regulations and procedures and budgetary controls.

One of the main clients in the Dutch construction industry is Rijkswaterstaat. Rijkswaterstaat (RWS) is tied to legal procurement frameworks which are defined in the procurement regulation construction works (ARW, 2005). For works over 1.5 million Euros, RWS has to do a public procurement, for works over 5 million Euros RWS has to do a public European procurement. This public procurement procedure goes as follows: RWS has to do a (pre)announcement of the work to be tendered. A term is set for the acceptance of the tenders. The contracting authority takes up the technical specifications in the tender documents. Also the specification of the work, like the award criteria (MEAT or lowest price), are documented. Furthermore the grounds for exclusion have to be included. The potential contractor has to show its financial and economic capacity, technical capability, quality monitoring, environmental management standards and certification. During the tender period there are two information rounds during which the potential contractors can require more information. After the procurement term, the client takes an award decision if a contractor is chosen and no other potential contractor has made an successful appeal, the work is rewarded.

Partnerships in the construction industry
Because of the size, complexity and multi-disciplinary character of projects in the construction industry, companies often form alliances, combinations or partnerships (Keegan & Turner, 2000). Project partnerships can be seen as a means of transforming contractual relationships into a cohesive project team with a common set of goals and procedures (Beach, Webster, & Campbell, 2005). The competitive aspect of tenders requires good inter-organizational relations (Holt, Love, & Li, 2000) starting in the tender phase or even in the pre-tender phase (Beach, Webster, & Campbell, 2005). The intensity of the partnership depends on the project complexity and size (Beach, Webster, & Campbell, 2005). Sometimes organizations work so close together that
a new organization is erected for the duration of the project. These project organizations function like collaborative subsidiaries which have a relative amount of autonomy.

Different from (short-term) project partnerships are (long-term) strategic partnerships. Strategic partnerships are a long-term cooperation between two or more organizations in order to achieve specific business objectives (Holt, Love, & Li, 2000). Strategic partners can also be involved during the tender phase.

**Quasi-firm in the construction industry**
Subcontractors execute the services of special trade for the main contractor in a construction project (Eccles, 1981). The organizational form in which a main contractor contracts and collaborates with a subcontractor is called a quasi-firm (Eccles, 1981). Sub-contractors are often hired to take on some part of the project execution. These sub-contractors can be involved during the tender phase to contribute their experience and expertise to the bid. Other sub-contractors are hired during the tender phase the gain strategic advantage and to increase the chance of winning the bid. For instance engineering firms can be hired to do more research in order to get more clarity on the clients’ requirements. Another example of involved organizations giving advice during the tender phase are stakeholders. Stakeholders are earlier involved in the process (van Gunsteren, Binnekamp, & de Graaf, 2010). Especially for tenders which have MEAT award criteria it becomes more important to add value.

### 2.6.4 Conclusion on the CI

The construction industry is involved in the planning and building of some physical facility. Organizations in the construction industry are characterized by work oriented towards projects. Projects are unique endeavours which are limited in time, scope and resources, and which are outside of the normal organization. Organizations can be structured to project, to functions and to an intermediate form: the matrix structure. When an organization is self-organizing, it can be called a holographic organization.

The construction industry consists of all organizations involved in engineering, procuring and building constructions. The procurement consist of a design stage, a tendering stage and a bid evaluation. Tendering is the bidding process of the procurement. There are two award criteria for competitive tendering: Lowest price and most economically advantageous tender (MEAT). The bidding process for MEAT award criteria can be explained using the conceptual model for competitive bidding in MEAT. This model explains how internal and external factors influence the competitive position by differentiation for organizations in the construction industry.

Inter-organizational relationships are among those factors. The client is often a governmental body which ensures that the bidding process is bound by strict rules and regulation. Partnerships with other organizations are formed to deal with the complexity and size of construction projects. These can be (short-term) project partnerships and (long-term) strategic partnerships. Furthermore sub-contractors are involved in the tender phase to contribute their experience and expertise and to gain strategic advantages to increase the chance of winning the bid.
3 METHODOLOGY

3.1 INTRODUCTION

In this chapter the research methodology will be presented. The research methodology will be applied to structure the research and it provides a guideline on how to find research data, on how to deal with the data and the sources it was gathered from and how to apply it in the research. First the research phasing will be explained. Next the different phases will be explained; the literature study, the field study and the design phase. This chapter will be concluded with a schematization of the research and its (sub) phases.

3.2 RESEARCH PHASES

The methodology as designed for this research is schematized in Figure 7 (Pajares, 2007). The research consists of five methodological steps the first being the problem assessment, the second the literature study, the third the field study, the fourth the design phase and the fifth the conclusion.

The title of the first research step: the problem assessment speaks for itself. An indication of the problem is determined and the relevance to do a research in order to solve this problem is given. During the literature study current knowledge and literature on the subject in analyzed in order to underpin the research question. After the literature study the field study follows. The field study forms the empirical basis for research. This step is called field study because it consists of collecting and creating data outside a typical workplace. This location outside of the typical workplace can be somewhere else in the office or within another organization. During this step data will be collected within Boskalis and analyzed through which research finding can be developed and tested. Using the collected and analyzed literature and data, during the design phase a solution for the problem can be developed and tested in order to answer the postulated research question. Finally all steps must be verified and validated before coming to a research conclusion which answers the research question and solves the problem as assessed in the first methodological step.

During the literature study the first research question will be answered. During the field study, an assessment of the current situation on knowledge management for project-based organizations in the construction industry, the second research question, will be treated. During the design phase attention will be paid to the third research question. Finally forth research question on knowledge management in the construction industry and a more generic application for this research will be discussed during the field study and design phase.
3.3 LITERATURE STUDY

The literature study provides the background and context for the research problem (Pajares, 2007). It should establish the scientific need for the research. Furthermore it provides a framework for establishing the importance of the study, as well as a benchmark for comparing the results of a study with other findings.

The required literature will become clearer as the problem becomes more defined. The problem becomes more defined, among other things, by creating a background and context through a review of literature. For this iterative process the snowball method will be used (VU Amsterdam, 2012). If some literature is found which is important for the research, the citations in this research can be used to find more information on this subject. This is called snowballing on cited publications.

Publications sought, using this snowball method are graduation and dissertation thesis, books, journals, reviews, reports and proceedings. These were found on repositories and websites like Google Scholar, JStor, Science Direct and IEEE. In such search systems the number of citations and related articles are given. Using this metadata to search for literature is called snowballing on citing publications.

The snowball method allows for a directed search, but still there is a redundancy of information. To reduce this amount of information, first the summary, introduction and conclusions of publications are read and the headings are scanned. If the article seems relevant, the whole article is read and important phrases are highlighted. If there’s enough relevant statements made in an article, it is summarized. Furthermore to be able to be able to retrieve the relevant information quickly, the articles are documented on subject.

3.4 FIELD STUDY

The literature forms a basis for the field study. For instance it helps to determine what questions to ask during interviews. The field study leads to a better understanding of the problem, which then again leads to a more defined literature search. The field study is the empirical basis of this research.

3.4.1 EXPLORATORY INTERVIEWS

At the start of the research exploratory interviews are done. The goal of these interviews is to create a better understanding of what is going on within BKN in terms of knowledge management. The results of these interviews are used to determine what literature to further search for and what documents on knowledge management processes and means to search for during the next step of the field study.

During these exploratory interviews, nine interviews were taken. Interviewees were picked on function and availability. During these interviews questions were asked about Boskalis, kick-off meetings, evaluations, lessons learned, knowledge sharing and successes & improvements. A complete overview of the exploratory interview questions and answers can be seen in

3.4.2 STUDY OF CURRENT (KM) PRACTICES AND MEANS

The interviewees taking part in the exploratory interviews explained what practices and means they applied. This was used as basis for the study into the current practices and means at Boskalis. During this phase all documents and tools which could contribute to the transfer of knowledge within the organization were explored. The goal of this study into current knowledge management practices and means was to get a better understanding of the available practices and means; and to check all the interviews conducted within Boskalis (both the exploratory as the internal interviews). A complete overview of such tools and practices can be found in Appendix B – Current practices, therefore a brief summary is sufficient for now:
3.4.3 EXTERNAL INTERVIEWS

The literature study, exploratory interviews and study of current knowledge management practices and means within Boskalis helped to determine questions for the external interviews. There are multiple reasons for taking the external interviews.

- The first reason is to investigate whether there is a broader support for this research in industry.
- Secondly, it is to get a better view of the industry (in terms of knowledge management).
- A third reason is to provide BKN with an external motivation to start investing in this subject.
- The fourth reason is to acquire more ideas for this study.

In the external interview, five interviewees were selected on their function. Each interviewee is to a greater or lesser extent involved in knowledge management in their organization. Also the organizations they work for are an important selection criteria. The five interviewees work for organization in the construction industry. These organizations are active in fields in which Boskalis is already actively involved, or attempt to become a larger player in.

The first organization is a project organization involved in dredging, sea defences and infrastructure. The second organization is involved in infrastructure, construction, real estate and energy. The third organization is involved in dredging and engineering. The fourth organization is a construction company active in the infrastructure industry. The last organization is involved in the energy and offshore market.

These employees from other organizations were subjected to a number of questions. During these interviews questions were asked about their organizational culture, the nature of transferred knowledge, codification, personalization, the added value of lessons learned and problems arising around knowledge management. The questions on the organizational culture help to determine the relevance of the answers to Boskalis, and to help determine the relevance for the custom made solution for Boskalis to these organizations in the industry. A complete overview of the external interview questions and answers can be seen in Appendix C - Intervie

Because of the competitive aspects of other organizations in the construction industry confidentiality is important for the interviewees. Another reason to have a predetermined confidentiality agreement is to make them feel at ease and to create trust. This encourages knowledge sharing during the interviews. Such an agreement can be seen in the interview protocol (interview protocol, 2006) for external interviews, as can be seen in Appendix C - Interviews. Furthermore this interview protocol helps the interviewees to prepare for the interview, and making them aware of what they can expect.

3.4.4 INTERNAL INTERVIEWS

The main objective of the internal interviews is to empirically substantiate the theoretical basis for this research for the case of Boskalis in order:

- To determine the current situation at Boskalis Bebo with regard to knowledge management.
To determine boundaries to knowledge transfer in Boskalis Bebo and between other parts of the organisation.

To find the most appropriate knowledge management strategy for Boskalis Bebo and determine requirements for a solution.

To be able to best reach these goals, interviewees will be chosen to give a good reflection of the employees working for and with the department Bebo. Choice factors herein are the insights colour\(^1\), the seniority of the employee and the function he/she fulfils within the organization. A total of thirteen interviewees were interviewed during this phase of the field study.

All internal interviews were conducted in Dutch since everyone involved is a native Dutch speaker. The interview starts with some multiple-choice questions regarding the organizational culture, followed by open questions. Subject treated during these interviews are the corporate culture, project organization, the current level of Knowledge Management and requirements for a knowledge management strategy. A complete overview of the external interview questions and answers can be seen in Appendix C - Interviews.

An interview protocol, explaining why these interviews are conducted, what is done with the results and how is dealt with the confidentiality of the answers, was communicated with the interviewees. This protocol can also be found in Appendix C - Interviews.

### 3.5 DESIGN PHASE

In the design phase of this research, the US Department of Defence (DoD) systems engineering (SE) process (2001) is used to design a solution or advice for Boskalis. A schematization of this process can be seen in Figure 8. This process consist of process input, a requirements step, a design synthesis step and process output. Furthermore validation and verification loops are used to make sure that the right design is made and that this design is made correctly.

![Figure 8 US DoD Systems Engineering process](image)

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\(^1\) Insights colours are a team role inventory method. This method and its application within Boskalis Bebo will be explained in Appendix C - Interviews
First the requirements for this design will be determined. These requirements follow from the literature study and the field study (the process input). To validate these requirements (the requirements loop), a validation meeting is held. Since the practical requirements mainly follow from the internal interviews, participants were sought who did not take part in the internal interviews. Furthermore their functions, insights colours and seniority are selection criteria for the participants of the validation meeting. Seven participant took part in this meeting.

The GROW-methodology\(^2\) will be used to guide the meeting. The reason for this is because Bebo employees are familiar with this method, and it will make the meeting more effective. The participants also received a protocol for the meeting to prepare themselves. The validated requirements can be used to create a custom made design for Boskalis Bebo.

The design (design synthesis) is the most important product this research will deliver for Boskalis. It is custom made, trying to satisfy the research requirements (design loop). Also it will be determined how the design helps the organization to achieve some of its objectives (verification). Furthermore an indication will be given on how such a design can help other organizations in the construction industry and is an addition to the already known literature on knowledge management.

\(^2\) The GROW-methodology is a method used by Boskalis Bebo to guide collaboration meetings. Theory on this methodology can be found in Appendix B.1.1 – GROW methodology.
4 BOSKALIS

4.1 INTRODUCTION

In this chapter an introduction to the case: Boskalis’ Bebo department will be given. During the exploratory interviews and study of current knowledge management practices and means, information was gathered which will be presented here.

First an introduction to Boskalis will be given; the history, the organizational structure, the type of projects Boskalis is involved in and the (organization of) Boskalis Bebo will be explained. The department Bebo is responsible for obtaining projects by participating in tenders and the way they do that will be explained in the next paragraph. Their tender process and when a tender is successfully won will also be discussed. Finally the inter-organizational relationships with the client and partnerships during the tender phase will be explained.

4.2 HISTORY OF BOSKALIS

The predecessor of Boskalis, the firm Kraaijeveld and van Noordenne was established in 1910 (Bouwens & Sluyterman, 2010). After the First World War, had developed itself as a key player in the Dutch dredging industry being awarded in a number of important assignments for the Zuyder Zee works. Typical for a dredging organization in that time is that expansions of equity capital came about by bringing in new business partners and constantly rechanneling profits into the company. This also happened for new partners Bos and Kalis. In 1930 the firm was converted into the public limited dredging Bos&Kalis. One of the first challenges for Bos&Kalis was to keep afloat during the depression (Bouwens & Sluyterman, 2010). They faced the depression by being cautious and investing, for instance in a home market in England. In 1933 the Westminster Dredging Company was registered in London. During the Second World War this British subsidiary was in operation while the parent company saw its activities decline.

Two world wars and a depression had thrown Boskalis a bit back to their own country, however, internationally the Dutch dredging industry was still known for their good reputation (Bouwens & Sluyterman, 2010). The global economic growth, the Delta works and expansion of the oil industry enabled Bos&Kalis to grow exuberantly. Bos&Kalis managed to secure a leading position within the Dutch dredging industry by not letting clashes between relatives in the company be the reason for the company to disintegrate. One of those clashes was the clash between the practical skilled family Kalis and the more technical schooled family Bos about the formation of a construction department. After some tussling the central technical department was founded in 1963 in Papendrecht and was engaged in repair, design and research.

In 1971 the family business went public and took on the name Bos Kalis Westminster Dredging Group NV (Bouwens & Sluyterman, 2010). The flotation gave them wider possibilities for takeovers. During the seventies the company was diversified by involving adjoining activities to the company. These adjoining businesses units
retained considerable autonomy. Because of this, little interaction and synergy was created between these units. The diversification made the organization larger and more complex, but professionalization failed to keep pace. Management was characterized as unsystematic, ad-hoc and had a large willingness to take risks. Mid-eighties Boskalis balanced on the brink of bankruptcy because of large risks, slow financial reporting, and a sluggish economic climate.

With the support of the banks and a reorganization plan that concentrated on dredging activities, Boskalis got another chance to prove itself (Bouwens & Sluyterman, 2010). With its global orientation, knowledge, experience and willpower of the company employees showed tremendous resilience and Boskalis was able to fight its way back to the top. Gradually a process of professionalization took place allowing the organization to be transformed into a more streamlined organization in which increasingly complex projects could be realized.

In the nineties the capacity of dredging equipment increased enormously and previously closed markets became accessible. The attendant expansion and management were aligned with the expectations of clients. In order to strengthen the continuity, Boskalis applied a ‘home market strategy’. This is a strategy for Boskalis in order to gain a more permanent position in a relevant host country. The home markets are characterized by a strong local embedding of Boskalis. Besides Great Britain, which has traditionally been an important home market, also Germany, Finland, Portugal, Mexico, Sweden and Nigeria, became countries with a home position for Boskalis. In 1998, 50% of the turnover existed of turnover from home markets. Apart from turnover home markets also supply a transaction of knowledge.

The first decade of the 21st century was a succession of economic and financial crises (Bouwens & Sluyterman, 2010). A broad portfolio helped the organization to compensate for setbacks in one area with new opportunities in another. Acting on withdrawing governments Boskalis developed itself more as project director. This requires more knowledge of design, laws, regulations, contracts, financial flows, environment, security, politics and dealing with a critical environment which continually asks for explanations. Despite a less fortunate outcome of the diversification period in the seventies, there still was a desire to broaden the activities. With the takeover of the maritime service Smit International (Press release Royal Boskalis Westminster nv, 2008), MNO Vervat in 2011 and Dockwise in 2012, this has succeeded. In 2010 Boskalis celebrated its centenary with the addition of the epithet Royal to its name.

### 4.3 ORGANIZATIONAL CULTURE

Boskalis organizational culture did not appear over night. Hundred year of experience, successes and difficulties, operating in national and international markets have made the organization and its culture to what it is today. In Paragraph 2.3.3, six dimensions were given which can help to characterize and understand the organizational culture. To characterize the organizational culture for Boskalis, during the internal interviews 32 multiple choice questions were asked.

![Figure 9 Dimensions of corporate culture at Boskalis](image)
on the organizational culture. In total 14 interviewees answered these questions. The interviews and interview questions can be seen in Appendix C - Interviews. The results on the six dimensions for Boskalis are presented in this paragraph and can be seen in Figure 9. During the exploratory interviews, some examples of the corporate culture were mentioned by interviewees. These are used to substantiate the results.

The first dimension is Goal vs. Means orientation. Boskalis has a Goal-oriented culture. “What” work is done is of importance to employees. Employees are striving to reach a certain goal or result, even if this involves taking some risks. These goals are often short-term goals which require little means for the long-term. The employees can be characterized as direct, have an informal way of dealing with each other and the board consists of doers.

Boskalis is an externally oriented culture. Such organizations often operate in competitive markets and focus on meeting customer requirements, as interviewee 4 (2012) puts it: “At Boskalis we do client-driven tenders. If Boskalis can respond to the client’s future desire, we have an advantage in trying to win the tenders.” Some interviewees indicate that there is not enough emphasis on satisfying the customer demand but that a shift is occurring towards an increased emphasis. Furthermore all interviewees indicate that they are more pragmatic in ethical matters.

Boskalis has an Easy going work discipline. When an organization is involved with more innovative and unpredictable activities, they are often more easy going. There is little control and discipline. Employees love to make jokes and have no strict dress code, they only strict dress code is for safety purposes.

Boskalis culture can be characterized as Local organization with the ambition to become more professional. Employees in a local organization identify with their own department. Employees rather blend in than think it is important to show their own identities; and that selecting new employees on basis of how well they fit in the organization is more important. The differences between the two extremes of this dimension are small.

To substantiate how interviewees indicate an ambition to become more professional, as example the multiple-choice question on cooperation and trust between departments is taken. Many interviewees indicated during the multiple-choice questions that there is trust and cooperation between the departments, but refute this later during the interview. Also other departments and organizational layers were often not aware of activities within the department Bebo. For instance the GROW cases. Many colleagues not working for Bebo were not aware of the existence of the GROW cases or of what was happening during the cases. This shows that there is a desirability to increase the trust and cooperation between departments.

The next dimension is closed vs. open system. As can be seen in Figure 9 the corporate culture at Boskalis can be characterized as a closed system. This dimension is closely correlated to the national culture. Dutch organizations tend to be more closed systems. Furthermore it has some correlation to the femininity of the organization. In a more masculine organization, employees will try to solve the problem themselves before asking help from colleagues. Interviewee 9 (2012) said the following about the masculinity of the organization: “Boskalis is a very masculine culture. People are very blunt and like to take on action. They like to start working on solutions before the problem is known”. Furthermore interviewees indicate that little controversial issues appear in the department journal and it takes a while for new employees to be integrated into the corporate culture.

Finally, Boskalis is a Work-oriented culture. The organization is operating against external standards. Managers keep good people for their own departments and changes are top-down imposed. Performing work is the organizations main responsibility and this can be done at the expense of employees.

To characterize Boskalis’ organizational culture in one paragraph: Its employees are comfortable in unfamiliar situations; they are risk takers who take pride in being unrestrained. They are motivated by reaching short-term goals. The low number of woman employed at Boskalis adds to the masculinity of the culture.
have a clumsy and direct way of confronting colleagues, people are thrown in the deep and little attention is paid to making new employees feel at home. Luckily they hire people who fit in the organization and feel comfortable with such cultural characteristics. This hiring criterion is an attribute of a local, non-professional culture.

4.4 Boskalis Projects

The take-over of MNO Vervat enabled Boskalis to strengthen its position in the Dutch infrastructure market (Persbericht Koninklijke Boskalis Westminster NV, 2011). This Dutch infrastructure market is one of the markets Boskalis is active in. Boskalis’ main activity is earth moving. This can be either dry or wet earth movement. Movement can be the removal or replenishments. Furthermore different types of soil can be moved. Besides the main activity of earth movement, related activities also fall under Boskalis’ expertise. Some examples of earth moving activities Boskalis is involved in are (Boskalis Nederland, 2011):

- The construction of stable embankments for infrastructure,
- The dredging of the location for and the placement of caissons,
- Dike reinforcements,
- Coastal and underwater nourishments,
- The maintenance of waterways,
- Soil analysis and remediation
- Nature development,
- Preparing construction sites
- Land reclamations

A good example of projects that require many of these activities are the ‘Ruimte voor de Rivier’ (space for the river) projects. The ‘Ruimte voor de Rivier’ (RvdR) projects are key planning decisions from the Dutch government. The projects are initiated to prevent flooding of major rivers in the Netherlands and to improve the “spatial quality” of the rivers (Ruimte voor de rivier). There are over 30 projects along the Dutch rivers requiring dike relocation, excavation of the river foreland, depolderization, deepening of the summer bed, lowering of the groins and nature and recreational development. Not only the size and the technical aspects of these projects are complex and challenging. But also the stakeholder involvement and control of contract are often challenges for Boskalis.

Another example of a characteristic work that Boskalis was awarded is the rerouting of highway A9 (Wegen, 2012). This infrastructure project was awarded as design and construct (D&C) contract. This contract form makes this project interesting for Boskalis as they can exert their influence during the design phase.

Finally the project ‘Sand engine’ (in Dutch Zandmotor) has been a technically challenging project for Boskalis. This project is an experiment in the scope of dynamic coastal management (Persbericht Koninklijke Boskalis Westminster NV, 2010). The 21,5 million cubic meters of sand, of which the sand engine exists, will gradually be displaced along the coast because wind, waves and currents. Because of this the coastline will be maintained in a new and natural way, hereby creating new space for nature and recreation.

In all these projects, NINA is a spearhead (1, 2012). NINA, or No Injuries, No Accidents, is Boskalis’ safety method. The motivation for developing this safety method the customer demand for a (low) Injury Frequency Rate (IFR). NINA has become a success in the organization because of the long-term dedication and investment of the higher management, and the simplicity and personal character of this method (7, 2012).
4.4.1 ORGANIZATIONAL STRUCTURE AT BOSKALIS

Royal Boskalis West ministers’ Dutch home market is called Boskalis BV with its main office based in Rotterdam. This home market has a number of subsidiaries which are all private limited companies (Boskalis Nederland, 2011). The contractors Markus and MNO Vervat have a lot of autonomy. Boskalis Hoek van Holland and Capelle aan de IJssel have less autonomy. Boskalis has with regard to Royal Boskalis Westminster a lot of autonomy. Boskalis is able to set its own goals and own ordering, they have their own social identity, they have their own resources to fulfil and complete tasks and the freedom to choose how to interact between employees. A schematization of Boskalis’ organizational structure can be seen in Figure 10.

The direction manages the company managers, who in turn are responsible for a subsidiary and/or projects. The direction also manages heads of the staff departments. The subsidiaries and projects can make use of the advice and support of the staff services.

<table>
<thead>
<tr>
<th>Turnover (in mln €)</th>
<th>Risk high</th>
<th>Risk low</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO &gt; 100</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>25 &lt; TO &lt; 100</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>5,0 &lt; TO &lt; 25</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>0,35 &lt; TO &lt; 5,0</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>0,35 &gt; TO</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 Project classification

In Figure 11 an example of a project organization for Boskalis is shown. The company manager is responsible for classifying the project (SHE-Q department, 2010). The more complex the project, the stricter and active the risks, safety, environment, quality, time and money need to be quantified, controlled and managed. In Table 3 a classification of projects can be seen ranked from very complex to non-complex. This classification does not only indicate the level of strictness of adherence to project management, but also organizations which are involved in the project. If a project is very complex, Royal Boskalis Westminster should be involved. If a project has a lower level of complexity, Boskalis or one of its subsidiaries can be involved.

Boskalis structure is not a pure structure like the once presented in Chapter 2. Boskalis is more of a project organization because the structure is organized around projects. The staff departments give some functional specifications to the organizational structure. Furthermore Boskalis has some aspects of a holographic organization. For instance in projects or within the department Bebo it is expected to show a high level of self-organization, “Everyone is his own manager” (2, 2012).

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3 This figure was adapted from (Sijl, 2011) and (SHE-Q department, 2010)
4 This figure was adapted from (SHE-Q department, 2010) and (SHE-Q department, 2010)
4.4.2 DEPARTMENT BEBO

Bebo is short for Bedrijfs Bureau (Organizational Bureau). The main activity of this department is obtaining projects by participating in tenders. Obvious functions within this department are tender coordinators and tender employees, but also survey, calculation, cost engineers, process managers, commercial managers and legal advisors are part of department Bebo. Some employees from project execution are starting in the tender phase, to continue in the execution phase. Besides participating in tenders, R&D for Boskalis is also Bebo’s responsibility.

There is little structure within the department; this has to do with the holographic organization of the department. The self-organizing quality of this department can be seen in non-formalized job descriptions (7, 2012) and a high responsibility and freedom in finding and executing your work (3, 2012). Currently there are plans to create a more formalized organizational structure for the department Bebo, but this plan has not yet been laid out.

In 2011 the Bebo department formulated objectives which were rolled out in a mission statement, a vision, success factors and nine categories of objectives. This document of objectives is called the A3.

**Mission**
The organizational bureau of Boskalis NL (Bebo) ensures – as heart and head of the organization – the continuity of operations through which Boskalis NL can optimally achieve its objective.

There are five success factors which will make Boskalis Bebo successful in winning tenders:
- Divers and qualified employees
- Substantive involvement
- Effective and efficient operations
- Effective and efficient communication
- Healthy working environment

For this mission and these success factors are the, in total 68, objectives for the organizational bureau (Bebo) drafted. The complete A3 with all the objectives can be found in Dutch in Appendix B.2 – A3 Out of those 68, one of the most important objectives for this research is objective 7.02:

**Objective 7.02**
The score (on a 10-point scale) for knowledge transfer within the department Bebo will be increased from a 5.5 in 2011 to 7.1 in 2012.
Other objectives which are also important for this research are:

6.02 In 2012 will Boskalis obtain an average of at least 75% of the MEAT score

7.01 The score on effective communication within Bebo increased from a 6.3 in 2011 to a 7.6 in 2012 on a ten-point scale

7.03 The score on a ten-point scale on collaboration increased from a 6.8 in 2011 to a 8.0 in 2012

4.5 TENDERS

4.5.1 WORK INSTRUCTION TENDERS (WIT)

The department Bebo is responsible for obtaining projects by participating in tenders and for the tender process. The Work Instruction Tenders (WIT) provides descriptions for the generic steps that are should be completed within a tender process (Werkinstructie Tenderen BKN, 2012). Boskalis’ core processes are described in the quality management system, created by the Safety, Health, Environment and Quality department (SHE-Q). The WIT is a supplement to these core processes, developed by the department Bebo. It is seen as a support or a guideline for the tender process (1, 2012). There are no obligations to this process and it depends on the tender manager how and to what extent it is applied.

The WIT consists of seven phases with accompanied sub-steps. For the structure of these phases and sub-steps, the systems engineering (SE) methodology used. This is schematized in a flow chart, which can be found in Dutch in Appendix B.3.1 – Flow chart. The phases are the preparation phase, the requirements analysis, the functional analysis and allocation, the design phase, verification phase, the bidding phase and evaluation phase. An additional phase that is not included in the flow chart is the transfer phase. For every phase in the WIT an explanation of the objective of this phase, the input, sub-steps, tools, output, success factors, chance and risks are given.

As was explained in Paragraph 2.6.2, in the procurement process the tender phase is followed by a bid evaluation. During this phase the client evaluates and assesses offered bids and determines which bid best meets their demands. This bid is selected. In case of the lowest price award criterion, the lowest bid best meets their demands (5, 2012). In case of MEAT criteria evaluating, assessing and selecting the bid is a bit more complex. Every client has his own methods for completing the bid evaluation phase. The most common method is evaluating and scoring the bids on how well they meet the award criteria. This score is converted to a monetary amount. These monetary amounts are subtracted from the bidding price which leads to a fictive price. The bidder with the lowest fictive price is selected by the client.

The bid evaluation phase ends when the client informs the bidders whether they won the tender. Depending on the client, sometimes the bidders are also informed of the ranking, bidding prices, fictive prices and the MEAT scores of all bidders. After informing the bidders, a 15-day Alcatel period5 starts in which the other bidders can make an appeal. If no appeal is made within those 15 days, the client finally makes the official award decision. The bid evaluation phase is important because during this phase the success of the tender phase is determined.

4.5.2 SUCCESSFUL TENDERS

Successful tenders for Boskalis

As was indicated in the previous paragraph, for every tender phase success factors are identified. These success factors are internal factors which influence the company’s position in the bidding process and add to a

5 This period is called the Alcatel period, named after the case C-81/98, in 1999, the Alcatel-arrest (Steyger, 2010)
successful tender. The success factors can be found in Appendix B.3.2 – Success factors per tender phase. The WIT is developed for tenders with MEAT award criteria, but it can also be applied for tenders with lowest price award criterion. A tender is successful for the Boskalis when:

1. Boskalis wins the tender
2. For the highest possible bidding price
3. And the highest possible MEAT score
4. If the distance to the price of the number 2 is as small as possible
5. While a realistic price is offered

Winning the tender is an obvious success criterion. Not winning a tender is a waste of the effort put in the preparation of the tender. However you cannot win all tenders. In the A3 Boskalis has set the goal to win at least one out of three tenders (objective 9.06). Many organizations in the construction industry therefore calculate an extra sum into the strategic price to compensate for the effort put in the lost tenders.

If Boskalis wins the tender for the highest possible bidding price, they will make the most margin of profit out of the project. This is in line with objective 9.02, the pursuit of achieving a margin of profit of on average 8.4%. The highest possible bidding price while still winning the tender is the price just below the price of the number two bidder. When there is a big price difference between the number one and number two bidder, you let the opportunity to make more profit slip. The difference between prices of the number one and number two applies for the lowest price criterion for the bidding price and for MEAT criteria for the fictive price.

Since for the lowest price award criterion there are no MEAT scores, the third success criterion does not apply for the lowest price award criterion. For tenders with MEAT award criteria however, this is an important success criterion for Boskalis. In the A3 in Appendix B.2 – A3 one of the objectives is to obtain an average of 75% of the MEAT score (objective 6.02). The fictive price is the bidding price minus the sum of translated MEAT scores into monetary amounts. Therefore, if the MEAT scores are high, the bidding price can be higher while achieving the same fictive price thus being able to make more profit.

The fifth success criterion cannot directly be traced back to an objective, but this becomes clearer because of the economic crisis. Some other organizations have a great need for work and will bid bottom prices. Bidding such prices is a desperate act and going along in bidding such prices is not good for your organization and the (margins) of profits you make. Therefore it is important to bid realistic prices.

Factors in competitive bidding in MEAT

In the model of competitive bidding as presented in Paragraph 2.6.2 – Tender phase two groups of factors of competitive bidding are explained; internal and external factors. The external factors you cannot influence in order to make your tender process more successful you can only mitigate risks. An example of such a mitigation was given in a previous subsection; namely the calculation of an extra sum of money in the strategic costs in order to compensate for the lost tenders.

The internal factors you can however influence by Boskalis. The conceptual model of competitive bidding in MEAT has one goal: influencing the probability of winning the tender (first success criterion). As can be seen in this model, both internal as external factors influence this success criteria, and can therefore partly be influenced by the organization itself. The third success criterion, the highest possible MEAT score, can be most influenced by the organization itself. Since the (general) MEAT award criteria are disclosed by the client, by implementing a process of understanding, fathoming, and satisfying the clients demand, you can influence this third success criterion as organization. The last success criterion is dependent on choices an organization makes and therefore dependent of internal factors. The remaining two factors, highest possible bidding price and the small distance to the price of the number two depends largely on bids competitors make. Since it is
illegal to make price agreements with competitors in the bidding process, these success criteria can therefore not be influenced by the organization itself.

4.6 INTER-ORGANIZATIONAL RELATIONSHIPS

The large and complex projects with long life-cycles, multi-disciplinary teamwork and cross functional cooperation Boskalis is involved in, require a good understanding and a tailor made product for the client and a good cooperation in partnerships and quasi-firms. In this paragraph therefore more information is given on Boskalis’ clients, partnerships, subcontractors and the current situation in the Dutch construction will be explained.

4.6.1 THE CLIENT

The client plays an important role in the projects Boskalis is involved in. One of the objectives therefore has to do with client satisfaction and prioritization: Prioritize clients who are financially and strategically important priority. These clients are ranked: 1. RWS, 2. Port authorities, 3. Municipalities / Water boards. (Objective 6.04)

Rijkswaterstaat (RWS) has been one of the oldest and most important clients. RWS is financially very important for organizations like Boskalis. The most tenders for the highest total amount are done commissioned by. Also strategically RWS is important to Boskalis. For the longer term the relationship with RWS is one to invest in. Projects Rijkswaterstaat commissions are for instances the highways and national sea defences. Since the number of road users is increasing (CBS, 2013), the sea level is rising and discharge of rivers increases due to the climate change (Deltacommissie, 2008), in the near and more distant future, RWS will need to commission a number of such projects. On top of this, these projects need maintenance which can provide Boskalis with a continues source of income.

Port authorities need maintenance of the waterways in the ports in order to prevent siltation and to guarantee a certain draught. Such work can provide Boskalis with a continues source of income. The importance of this type of client is strategic in nature. For the last two years little tenders have been commissions for port authorities, making it look like these parties do not have much financial importance. However a port extension is a major project. Such projects occur less often, but when they occur, they have a major financial importance, as can be understood from the Tweede Maasvlakte, an extension of the Port of Rotterdam.

Municipalities need preparation of construction sites and remediation before construction of for instances residential areas or local roads can take place. Water boards are responsible for local water projects such as the ‘Ruimte voor de Rivier’ projects and dike reinforcements. All in all do these clients put up a significant number of tenders for a considerable amount of money and are therefore financially important to Boskalis.

Other clients are provinces (responsible for the construction and maintenance of provincial roads), foreign governments (the Dutch home market of Boskalis also covers Belgium) and private organizations. This last group of clients is the only non-(semi-)governmental group Boskalis is working for. Private organizations mostly commission energy related projects. These organizations only provide a small proportion of all the projects and profits for Boskalis.
4.6.2 PARTNERSHIPS

Around 75% of the profit is won by projects which are done by a combination. The reason to participate in a combination is because such projects are often larger, more complex, more risk is involved and more disciplines are required than for projects which are done by Boskalis alone.

Boskalis has another long-term relationship (a strategic partnership) with Van Oord, also one of the largest dredging companies in the Netherlands. This partnership is project size related. An example of a project executed by this combination is the Tweede Maasvlakte. In these type of projects, the biggest competition are the two largest dredging companies of Belgium, Jan de Nul and DEME. In smaller projects, Van Oord is often competition.

Boskalis has formed another long-term cooperation (a strategic partnership) with the organizations Volker Wessels and Heijmans. These organizations will try to work together when a work requires multiple disciplines. For every project they are involved in together then a new, short-term project partnership will be agreed to. Van Oord has a similar partnership with BAM and Strukton. When Boskalis and Van Oord formed the combination PUMA for the execution of the Tweede Maasvlakte, Volker Wessels and BAM formed the combination BAVO, in charge of the infrastructure part of the project.

Boskalis employees often encounter difficulties in collaboration in combinations. These difficulties are mainly due to the organizational culture and the way of working. As interviewee 5 (2012) explains: “Boskalis is a close group in which everyone knows each other and takes responsibilities. It becomes harder to work this way in large combinations. Some combinants are very hierarchical and have a macho culture this does not contribute to the quality which Boskalis is used to supply.”

4.7 CONCLUSION

Boskalis has been in business for over a hundred years and because of its contribution to the industry and to the Netherlands it was granted the epithet Royal in 2010. Their organizational culture is deeply rooted in operation in the Dutch (and in foreign) construction industries for over hundred year. Their organizational culture can be described as goal oriented, externally driven, with an easy-going work discipline and an orientation towards work. Over time the organization has not lost its local, familiar atmosphere and is dominated by a Dutch, masculine, closed community. However employees indicate an ambition to become a more professional and open organization.

Boskalis main activity is earth movement. Based in Rotterdam, Boskalis can organize all activities related to earth movement for the Dutch home market. They do so organized in a number of staff departments, subsidiaries and projects. One of these staff departments is Bebo (Organizational Bureau). The Bebo department has a high self-organizing ability. The main activity of this department is obtaining projects by participating in tenders.

The Work Instruction Tenders (WIT) provides Boskalis with descriptions for the generic steps that are should be completed within a tender process. The WIT is developed for tenders with MEAT award criteria, but it can also be applied for tenders with lowest price award criterion. A tender is successful for the Boskalis when:

1. Boskalis wins the tender
2. For the highest possible bidding price
3. And the highest possible MEAT score
4. As the distance to the price of the number 2 is as small as possible
5. While a realistic price is offered.

6 This is an estimate since not all the results of tenders are stored in a common point
The WIT provides internal factors which can influence the company’s position in the bidding process and add to the successfulness tender.

The type of projects Boskalis is involved in require a good understanding and a tailor made product for the client and a good cooperation in partnerships. Boskalis main client is Rijkswaterstaat, other important clients are port authorities, municipalities and water boards. Boskalis has some long-term partnerships, for instance with organizations Van Oord, Volker Wessels and Heijmans. For each project they work in together, a new short term project partnership will be agreed upon. However, working for and with these other organizations can be challenging due to differences in organizational culture and ways of working.
# 5 Boskalis and Knowledge

## 5.1 Introduction

In this chapter the results of the internal interviews will be presented. During these interviews Boskalis employees were asked to answer some questions on what they think is important knowledge for the organization, what activities and means there are available in the organization to manage this knowledge and what long-term strategy the organization has with regard to knowledge management. These interviews and the results can be found in Appendix C – Interviews. The interviewees were selected to give a decent representation of the organization. The selection criteria can be found in the same appendix in the interview protocol. These interview results have been verified during a validation meeting and by the interviewees themselves. The notes from the validation meeting can also be found in Appendix C – Interviews.

In order to provide Boskalis with some insights into their position in the developments in knowledge management compared to the construction industry, some employees from other organizations in the construction industry were interviewed. These interviews can also be found in Appendix C – Interviews. These interviews were used to paint a picture of activities around knowledge, knowledge management and knowledge management strategies in the industry.

First will be explained what knowledge means for Boskalis; How knowledge new is created through conversion, which subjects are often discussed and between which groups these types of knowledge are transferred. Next will be explained what knowledge management activities and means are available in the organization and at what level of maturity that brings Boskalis’ knowledge management practices. Finally some results from other organizations in the industry will be presented.

## 5.2 Knowledge

“Often you are unaware of the necessity of sharing some knowledge and you find out afterwards.” (27, 2012)

In this paragraph will be explained which knowledge is shared within Boskalis, and what the necessity of sharing this knowledge is for the organization. Therefore will be discussed in this paragraph which how knowledge is created in the organization, on which subjects knowledge is shared and between which groups these types of knowledge are transferred. Next will be explained what knowledge management activities and means are available in the organization and at what level of maturity that brings Boskalis’ knowledge management practices. Finally some results from other organizations in the industry will be presented.

### 5.2.1 Modes of knowledge creation within Boskalis

For many Boskalis employees Knowledge = Experience. These two concepts are often mentioned in the same sentence; “There is much experience and knowledge imbedded in people” (25, 2012). New employees have to prove themselves and have to gain experience before they can obtain information (Strategy of GROW-cases, 2012). They share this experience through tacit-to-tacit knowledge conversion, or socialization.
problems arise, that is when employees will start sharing experiences (22, 2012). The most practiced method to share experiences is to pick up the phone and call an experienced colleague (20, 2012). This type of knowledge is indissoluble interconnected with its carrier. Therefore the knowledge carriers are of great value to Boskalis. Sometimes after retirement pensioners still receive phone calls (27, 2012)

Knowledge within Boskalis is also often characterized as practical “A knowledge transfer should be practical and it should be project specific. You should try to reflect the knowledge onto your own project” (16, 2012). A number of interviewees feel that documented knowledge has two practical disadvantages; first it is hard to carrier along and to find this knowledge on projects (especially during project execution). Knowledge in your head is much more practical in such circumstances. And the second disadvantage is that codified knowledge has not been applied in practice. “You should have some certainties and know about previous successes before applying new knowledge; you cannot get this from books” (15, 2012). For such employees little conversion from explicit to tacit knowledge or internalization takes place.

However, new employees divert to explicit to tacit knowledge conversion. One reason is that coming across as layman portraits you as inexperienced which, on its turn, inhibits the search for information (23, 2012). Another reason is that new employees are not aware of the expertise of other employees (25, 2012). Finally they are more used to using computers to find information. New employees learn a lot from the internet, project documents and former school books.

When talking about knowledge with the interviewees, little is mentioned about the conversion from tacit to explicit knowledge (externalization) or the conversion from explicit to explicit knowledge (combination). The creation and application of manuals or recommendations is, if any, very informal. And information processing is low on the agendas of many employees. Interviewee 15 (2012) said “I’ve not yet seen any project end reports (PER) or executive summaries. They are probably stored on some shelves”.

5.2.2 Subjects of Knowledge

For the tender phase of a project, different parts are differentiated by Boskalis employees: the technical part and the qualitative part. Different knowledge subjects can then be differentiated which are important for the tender phase of a construction project: Technical and Qualitative knowledge

Technical knowledge

When employees speak of experience most often they are speaking about technical experience, and the financial and planning aspect of technical interventions. When you ask interviewees open questions like “Can you give an example of a transfer of knowledge that had a positive effect on the project performance?” Most of them will give a technical example which had a positive effect on the project performance. These technical elements are also the generic traits between projects. “Organizations have to do projects with generic traits in order to become good at what they do” (20, 2012).

Technical knowledge is then for Boskalis all knowledge required to calculate a construction, to estimate the costs, time and risks of a construction and knowledge on how to execute and to survey what is constructed.

Knowledge on these technical aspects of a construction project has been proven in practice in the organization for over a hundred years. Employees are very familiar with dealing with such subjects and therefore it is very concrete which knowledge to share and to assess its value. Technical aspects of projects are a frequent subject of discussion. The availability of in-house knowledge on technical subjects adds to the frequency of discussion. Furthermore technical knowledge is very static; changes in the industry on technical subjects occur slowly and technical aspects of projects haves many generic traits. Hard work and this technical knowledge can contribute to a low tender price.
Qualitative knowledge
Since the MEAT award criteria, there are more aspects to a project than making a construction on time and within budget. For instance quality, environmental characteristics, safety plans and stakeholder involvement need to be involved in the project. Such multi-disciplinary projects require a different process and management of contracts than for technical projects with the lowest price award criterion. These elements are what Boskalis often calls the qualitative part of a project. The knowledge on this qualitative part is different from the practical experience Boskalis has built up over the years. There is little experience with this qualitative part, and employees find it difficult to recognize the generic traits in this part; “The uniqueness of projects often lies in the qualitative part” (23, 2012).

Qualitative knowledge is for Boskalis all knowledge which is required for the tender phase of a construction project and which is non technical of nature. This is, for example, knowledge about processes and policies, aesthetic and functional characteristics, stakeholder involvement, contracts, Safety, Health, Environment, and Quality, collaboration, etc.

Employees feel there is little prove of the effectiveness of this knowledge on these qualitative subjects. Recent changes in tendering, required by the client created the necessity for these knowledge subjects within the organization. Employees are therefore more unfamiliar with such subjects and think it is unclear and vague. Also there is little availability of such knowledge within Boskalis which leads to infrequent discussion on qualitative subjects. The dynamic nature of this knowledge and the unique contribution of these aspects to projects make it even harder for employees in the organization to understand the value of this knowledge to the organization. Qualitative knowledge leads to clever work and achieving a higher MEAT score in tenders.

Knowledge paradox
The different experiences Boskalis employees have with technical and qualitative knowledge leads to a knowledge paradox. Both knowledge subjects have different dynamics, support a different way of working and add in a different way to winning a tender. Therefore both subjects are important for the organization to share. Important or unimportant, knowledge is not effectively shared when people do not care for sharing such knowledge. How much responsibility employees take in sharing knowledge, how frequently they discuss the different subjects, the palpability of the subject, their prove of the effectiveness of the different subjects and the in-house availability contribute how much employees care for sharing such knowledge. The importance of knowledge sharing and care for sharing knowledge in the organization can be seen in Table 4. Both qualitative knowledge as technical knowledge are of importance to the organization. Even though both knowledge subjects are important, employees do not care equally for sharing such knowledge.

<table>
<thead>
<tr>
<th>Unimportant to the organization</th>
<th>Important to the organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little care for sharing</td>
<td>Qualitative knowledge</td>
</tr>
<tr>
<td>A lot of care for sharing</td>
<td>Technical knowledge</td>
</tr>
</tbody>
</table>

Table 4 Knowledge paradox for technical and qualitative knowledge

5.2.3 KNOWLEDGE TRANSFER BETWEEN GROUPS
There are different groups within the organization in which and between which knowledge transfer takes place. These groups are somewhat like social networks within the organization. Smaller problems arise with the knowledge transfer within these groups than between the groups. These groups were defined as departments, project phases and seniority of employees.

The most evident groups are (sub) departments. As was explained paragraph 4.3 employees identify with their own department. A good example of this identification with their own department is given by a comment of interviewee 17: “Boskalis consist of a number of small grocers and not of one powerful chain retailer” (2012). The internal interviews showed that there are little problems with the knowledge transfer between all the employees located in one office. The problem starts to arise when employees of one department are no longer
located in the same building. One employee was located with his tender team in another office. He said during a GROW-case: “Walking in someone’s office for knowledge is quite difficult because you do not know anyone and we are far away from Boskalis. The tender team is in this office located on an island” (WIT stappen per contract, 2012).

The person in the previous example was back in the Rotterdam office and participated in a GROW-case so the knowledge transfer was not completely cut off. Bigger difficulties start to arise when employees of the department Bebo are working in the project execution. This brings me to the second group that exchanges knowledge: Project phases. Most of the Bebo employees are involved in the tender phase of the project. However some, and mainly employees from different departments are involved in the project execution phase. This gives problems for the transfer of knowledge between the tender and execution phase: “Projects are islands and are not part of the central organizational environment. Not many people are actively involved in the knowledge transfer between the projects and the office. Employees inside the office know well where and how to reach people outside on the projects. But there is little feedback from the projects to inside” (15, 2012).

Finally the knowledge transfer between newer and more established personnel could be improved. For new employees it could be difficult to acquire basic knowledge. While established employees have difficulty carry on their expertise when they retire. “People who have been with the company have a lot of knowledge which cannot be addressed anymore when these people leave” (3, 2012).

5.3 KNOWLEDGE MANAGEMENT

In the previous paragraph was explained which knowledge is important to Boskalis and its employees and how this knowledge is important and is shared. In this paragraph will be explained how the transfer of knowledge is organized, distributed and made accessible within the organization; and what maturity level Boskalis has achieved in managing their knowledge.

5.3.1 MATURITY OF KM ACTIVITIES

Knowledge management of Boskalis is at the initial maturity level. As can be seen in Figure 12 attention is paid to the transfer of knowledge. Knowledge management is ad hoc and little is standardized, comparable and repeatable. Little attention is paid to the knowledge management process, integrating it in the project management process, dedicating function to knowledge management or involving alliance in the scope.

Only for the initial maturity level significant numbers of interviewees recognize aspects of this level. When significant numbers of employees indicate a recognition of aspects of that level and the previous levels, an organization can be said to operate at that maturity level.
Initial level
At the Initial level the organization is working without paying any specific attention to knowledge management activities. 85% of the interviewees indicate that there is some form of attention to knowledge management activities. These activities are ad hoc; little is standardized, comparable and repeatable.

Boskalis employees were asked to indicate which activities and means they undertake to achieve a transfer of knowledge. The following activities were mentioned:

- Person-to-person communication (Calling and talking to colleagues)
- GROW-cases
- Portals
- Meetings
- Project End Reports (PER) and evaluations
- Shared drive
- Transfer between project phases
- Survey 2015 collaboration project
- Department journal

All these activities facilitate the transfer of knowledge, but the GROW cases and portals were most often mentioned. Therefore these will be highlighted.

GROW-cases are mentioned as the one of the most effective and promising way of knowledge transfer within Boskalis. Besides the knowledge transfer, the GROW cases had an effect on some peoples attitude towards knowledge sharing. They taught them how to give feedback (26, 2012), to admit a lack of expertise (21, 2012), or to become more close and open (19, 2012). Though some employees haven’t much changed their attitude towards knowledge sharing “Sometimes I think, a GROW session, is that a cry for help?” (Strategy of GROW-cases, 2012)

Having or not having changed their attitude towards the transfer of knowledge, most interviewees think that the GROW-cases can become a more effective means of knowledge transfer. GROW-cases are a good means for the short-term, but there is no feedback or information on what is done with the results (19, 2012). The cases are often on the same subjects (17, 2012) and are limited to Bebo (23, 2012).

Portals are not effectively used within Boskalis. There are a number of different reasons given by interviewees why these portals are currently not effective for the transfer of knowledge: 1. you cannot search for keywords, 2. it is difficult to know how to search (you need some to know what you are searching for), 3. the system is not up-to-date (16, 2012). 4. portals are not linked to other systems, 5. people are ignorant to using portals as means of knowledge transfer (19, 2012) 6. portals currently contain a redundancy of non-relevant information and 7. it costs a good deal of trouble before you can access a portal (26, 2012).

Knowledge discovery level
At the knowledge discovery level the knowledge management process is established in guidelines and is repeatable and comparable. Most interviewees think the knowledge management processes is not established. People indicate that there are some processes (like the WIT), but these are used as guidelines and checklists and do not pay specific attention to knowledge management. None of this is repeatable or comparable.

Knowledge creation level
At the knowledge creation level knowledge is documented, standardized and integrated in the project management process. Some interviewees indicate that some knowledge is documented, but very little is standardized or integrated in the project management process. Some interviewees even question what the use is of documenting some knowledge “Project oriented knowledge should not be documented” (16, 2012).
They fear it is not a sufficient way to transfer all knowledge (like experience) and say the context is hard to understand. Also people fear documented knowledge will be stored on shelves.

**Knowledge manager level**

At the knowledge manager level there are individuals and/or organizational units dedicated to knowledge management and the organization sets measurable quantitative goals which lead to corrective action on the KM process. There are no specified functions or departments dedicated to KM, but everyone on their own is responsible for knowledge management (18, 2012). Some people show their interest and take initiative in organizing some knowledge transferring activities, but no-one is really dedicated and responsible for knowledge management. There is also no corrective action to the knowledge management process.

**Knowledge renewal level**

At the knowledge renewal level the scope of knowledge management is broadened to the alliances of the organization. This is accidentally the case. It depends on initiative of the project manager and the confidentiality of the knowledge to be exchanged. Some knowledge is automatically transferred because of collaboration in combinations. Some people question whether you should be willing to reach this level, because you do not want some confidential, commercially sensitive information to reach your competing colleagues “Including alliances in the knowledge management scope is a sensitive topic; you want to keep some things back. These limitations do not count for MNO Vervat” (25, 2012).

Boskalis operates at the initial level of knowledge management, but for the other levels of maturity the interviewees also recognized some aspects. To explain this, a frequently given answer on whether alliances of the organizations are included in the knowledge management scope (knowledge renewal level) is used as an example. GROW-cases are sometimes done with alliances of the organization (for instance with project partnerships, sub-contractors or even the client). Whether they are done depends on the project manager. So sometimes alliances are included in the knowledge management scope. This is even done with some standardization because of the GROW-methodology. However such cases are done on an ad hoc basis. The GROW-cases are not comparable. They are done because someone is enthusiastic about it; not because a manager is dedicated and responsible for it and it is not included in the project management process. Even with some aspects of higher levels of maturity, Boskalis operates at the initial level of knowledge management.

**5.4 Knowledge management strategy**

At the initial maturity level on which Boskalis operates, knowledge management is ad hoc and little is standardized, comparable and repeatable. At this level the determination for activities is short term (maximum a year). Furthermore little attention is paid to the knowledge management process, integrating it in the project management process, dedicating function to knowledge management or involving alliance in the scope.

At this maturity level there are no long-term goals and objectives for the management of knowledge and no adoption of the courses of action and the allocation of resources for knowledge management. So currently there is no strategy for the management of knowledge.

The activities and means which are available are not sufficient to contribute to adopting the courses of action for (either a codification or personalization) knowledge management strategy for a number of reasons.

- The available activities and means haven’t been made available for a specific knowledge management course of action. It is not clear which activities and means are the right form of action for which types, subjects and groups of knowledge.
- It is not clear what the long-term objectives are the available activities and means should deliver. If you take for instance the portal, this has not been developed to provide a specific type of knowledge
transfer or for a specific other use. “No one ever requested a portal but different portals emerged anyway” (7, 2012).

- As was mentioned before, most available means and activities which facilitate knowledge transfer can become more effective according to the interviewees. A lack of allocation of resources makes an adoption of the courses of action in order to carry out any objectives difficult. Many initiatives are picked up by enthusiastic employees, but once they lose their enthusiasm or become engaged in more time consuming work the initiative is aborted. One of the enthusiastic driving forces behind the WIT said during a GROW-case: “My apologies, the WIT has also for me recently fallen to the background due to lack of time” (WIT stappen per contract, 2012).

5.5 CONSTRUCTION INDUSTRY AND KNOWLEDGE

Since Boskalis is an externally oriented organization, they attach importance to the industry. In order to provide insights into their position in the developments in knowledge management compared to the construction industry, some interviews were conducted with employees from other organizations involved in knowledge management in their organizations. The five interviewees (numbers 10 until 14) work for five different organizations in the construction industry also labelled according to the interviewee number. So interviewee 10 works for organization 10, a pure project organization. Interviewee 11 works for organization 11, a decentralized layered contractor. Interviewee 12 is involved supplying knowledge and new technologies from technical research to be implemented during the construction. Interviewee 13 works for organization 13, another contractor. The last external interviewee is employed by organization 14, involved in designing and procuring construction projects. An overview of the organizations culture compared to Boskalis’ culture can be seen in Appendix C.3.2 – External interviews.

Knowledge
All interviewees recognize the importance of knowledge in their organizations. However, there are differences in what knowledge the employees from the different the organizations think are important. For instance in organization 10, technical experience is an important form of knowledge although processes begin to become more interesting.

Another interviewee thinks knowledge about processes is mainly important; “Knowledge is a production factor within the industry and the company. However since the organization is a project-based organization you need to deal consciously with this knowledge. Knowledge about processes is more important than knowledge about the product” (11, 2012).

In organization 14 attention is paid to all four modes of knowledge conversion, and the subject of the knowledge depends on what knowledge gap need to be filled. Identification of the knowledge gaps is the first step in this organizations lessons learned process.

Knowledge Management
An assessment was made of the maturity levels of the organizations and Boskalis was compared to these organizations. This is an estimation since per organization only one employee was interviewed. However the goal is to give an indication of the construction industry and to provide Boskalis with insights of their position in the construction industry.

The maturity of organization 10 is somewhere around the initial level. There are knowledge management activities, like making use of the portal, evaluations a knowledge matrix and tutorial movies on technical issues. Knowledge management is still ad hoc and little is standardized, comparable and repeatable. Little attention is paid to the knowledge management process, or integrating it in the project management process, the interviewee took on some responsibility himself, but there is no function dedicated to knowledge.
management. The organizations within the project organizations are incorporated in the knowledge management scope but no other alliances are included in the scope.

The maturity level of organization 11 is around the knowledge creation level. There are knowledge management activities, processes which are established, repeatable and comparable. Furthermore there is documentation and standardization of documents which can be integrated in the project management process using three linked systems. There is a systems for process management. Another system is used to guide the Systems Engineering process and to capture project characteristics. The last system is the system which is used to store project documents. There are people dedicated to maintaining these systems, but there are no special knowledge managers.

Organization 12 has many knowledge management activities, like project-end reports, evaluations, portals, forums, memo’s, communities of practice, trainings, project start-up meeting, and the survey desk. These activities are however ad hoc. “A community of practice has started as hobby project on the portal in order to make connections between professionals. This hobby project has been successful, but no further action has been taken to create more communities of practice” (12, 2012). Also they are not established in a knowledge management process. Employees sometimes have trouble with new software, so little documented and standardized. Furthermore if someone starts and initiative, that person is responsible for it. “Anyone who wants to start a portal can start one. Usually the person who takes the initiative for creating a portal is also responsible for the portal” (12, 2012). But there’s no knowledge manager and also no evidence of involvement of alliances in the knowledge management scope. Therefore organization 12 is at initial maturity level.

Organization 13 has some lessons learned, evaluating, knowledge groups and other activities which facilitate the knowledge transfer. These activities are established, repeatable and comparable. They also lead to corrective actions on the process; however little is documented, standardized and integrated in the project management process. Also there are not yet employees dedicated to, only enthusiastic for it. Finally no alliances are involved in the knowledge management scope. Therefore this organization is ranged on discovery level.

Organization 14 can be found somewhere around knowledge manager or renewal level. There are many activities in this organization which lead to the transfer of knowledge. There is a lessons learned process which is established in guidelines and which is repeatable and comparable. The knowledge is documented, standardized and integrated in the project management process “Implementing lessons in projects is the most important part of the lessons learned process. If lessons do not come available or are not really implemented, people will get frustrated and will stop participating in the process” (14, 2012). The interviewees function is knowledge manager, illustrating the dedication to knowledge management. Furthermore measurable quantitative goals are set which can lead to corrective action on the knowledge management process: “The structured LL process, tracking usage and asking for feedback from users helps to find flaws which can be improved” (14, 2012). Finally they are involving different people to help improve the knowledge management process.
The results of the maturity of knowledge management of the different organization can be seen in Figure 13. Organizations 10, 12 and Boskalis are at the initial level, Organization 13 is ranged at the knowledge discovery level. Organization 11 can be found at the knowledge creation level, and organization 14 is ranging somewhere along the knowledge manager and renewal level.

**Knowledge Management strategy**

The organizations in the first two levels do not seem to have a long-term goal or objective, an adoption of the courses of action and allocation of resources with regards to knowledge management. Whereas the other two organizations have more evident strategies. Organization 11 has been using their systems for three years, and the interviewee from organization 14 explained “About 5 years ago the organization developed a process called PG12. In this PG12 they said, one of the deliverables of capital projects should be to learn from other projects” (14, 2012). When you’ve reached the knowledge manager level, you can already speak of a strategy. Because measurable goals are set that lead to an improvement of your process. At this point the short-term stage has been long passed.

Furthermore both these two organizations have a course towards codification. In their lessons learned process they put in a lot of effort in making the lessons explicit, without taking away the human context of knowledge “During the lessons learned workshop the group will validate these lessons. The person who brings in the lesson is asked to explain why it is a lesson. Then is determined within the group whether everyone understands the lesson, agrees with it and support it. Also the impact of the lesson and the likelihood of this lesson occurring again if no action is taken are determined” (14, 2012). Such a lesson is what organization 14 calls a high-quality lesson.

Organization 13, at discovery level has not yet established a strategy. This organization has passed the stage of cynicism and scepticism and is now trying to look forward. “You can only continue such a process when higher management invests time and money in it. For instance they should invest 0,1ft in people’s personal development and knowledge sharing. I am planning to give a presentation to the direction on the progress of knowledge groups to get the interest of the higher management” (13, 2012). The course of action has not been set yet.
5.6 Conclusion

The types of knowledge Boskalis attaches importance to are experience and practical knowledge. Most employees gain experience and create new practical knowledge through tacit to tacit knowledge conversion. New employees also make use of internet, databases and books which leads to explicit to tacit knowledge conversion, or internalization. Other forms of knowledge conversion are little practiced.

Subjects of this knowledge conversion are often technical of nature. Conversation about ‘the qualitative part’ happens less often. Qualitative knowledge is for Boskalis the ‘non-technical’ knowledge which is required for a construction project. This leads to a knowledge paradox in the organization. Technical and qualitative knowledge are both important for the organization but employees do not care as much for transferring qualitative knowledge as they do for technical knowledge.

The different types of knowledge and knowledge subjects are often available for certain groups. Between (sub) departments en between project execution and the tender phase little knowledge is transferred. Furthermore it is difficult for new employees to find the required knowledge and for employees who leave the organization difficult to pass on their knowledge.

The current knowledge management process at Boskalis contains a number of activities and means which contribute to the transfer of knowledge within the organization. These activities are ad hoc and not standardized, ranging Boskalis at the initial maturity level of knowledge management. At this level no long-term goals and objectives for the management of knowledge and no allocation of resources for knowledge management are made. Furthermore it is not clear what course for a strategy to manage knowledge would best fit the organization.

For a number of organizations in the construction industry the current situation with regards to knowledge management is similar. They can be ranged in the first two levels of maturity of knowledge management and have no clear long-term planning, set objectives or a course of action with regards to knowledge management. These organizations are all interested in knowledge management, but do not know what strategy to take. Two other organizations are on more mature levels of knowledge management and adopt a codification strategy. These organizations have been investing for a couple of years in their strategies. Seeking the creation of new knowledge on order to build new competitive advantages, knowledge has been institutionalized in the organization and the scope of knowledge management might even be broadened to the alliances of the organization.
6 REQUIREMENTS FOR A KNOWLEDGE MANAGEMENT STRATEGY

6.1 INTRODUCTION

In this chapter the requirements for a knowledge management strategy for Boskalis are determined. In the previous chapter Boskalis’ dealings with knowledge, knowledge management and its strategy towards the management of knowledge were assessed. A conclusion was that currently there are no long-term objectives, a course of action and no allocation of resources specific for knowledge management. To determine a suitable course of action for an organization, ten conditions for selecting a knowledge management strategy were determined in Chapter 2.

Interviewees were asked some questions on these ten conditions for selecting a knowledge management strategy. From these answers a course of action and requirements for Boskalis were distilled. This requirements analysis can be seen as the first step of a systems engineering process as was discussed in Chapter 3. In the systems engineering process developed by the US Department of Defence (2001), the requirements analysis is used to develop functional and performance requirements; customer requirements are translated into a set of requirements that define what the system must do.

These answers were validated and revised during the validation meeting (requirements loop). Both the interviews and the notes from the validation meeting can be seen in Appendix C – Interviews. Also interviewees during the external interviews were asked similar questions. What effective strategies for the interviewed organizations in the construction industry are, will also be presented in this chapter. Also these interviews can be found in Appendix C – Interviews.

6.2 REQUIREMENTS FROM LITERATURE

The answers of a majority (64%) of the interviewees lead the conclusion a personalization strategy would be most effective for Boskalis; this can be seen in Figure 14.

This 64% is not a convincing difference between the two strategies. Why this is will and the most effective course of action will be explained in the following paragraphs. Ten conditions arranged according to

![Figure 14 Knowledge management strategies](image-url)
three knowledge management components – people, processes and technology – will help to help determine requirements for a knowledge management strategy. These ten conditions can be seen in Table 5.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Personalization</th>
<th>Codification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Innovation</td>
<td>Innovative product</td>
<td>Mature product</td>
</tr>
<tr>
<td>2. Networks</td>
<td>Informal, dense social network</td>
<td>Formal network of databases</td>
</tr>
<tr>
<td>3. Motivation</td>
<td>Improved rep organization &amp; personal development</td>
<td>Being respected as expert by colleagues</td>
</tr>
<tr>
<td>4. Attitude</td>
<td>Easy going work discipline</td>
<td>Strict work discipline</td>
</tr>
<tr>
<td>5. Organization</td>
<td>Local, flat organization</td>
<td>Professional, layered organization</td>
</tr>
<tr>
<td>6. Community</td>
<td>Open system</td>
<td>Closed system</td>
</tr>
<tr>
<td>7. Sharing</td>
<td>Ambiguous, tacit knowledge</td>
<td>Explicit knowledge</td>
</tr>
<tr>
<td>8. Frequency of repeating tasks</td>
<td>Infrequent repetition</td>
<td>Frequent repetition</td>
</tr>
<tr>
<td>9. Willingness to follow processes and protocols</td>
<td>Goal oriented</td>
<td>Means oriented</td>
</tr>
<tr>
<td>10. Cost-efficiency of a database</td>
<td>Inefficient</td>
<td>Efficient</td>
</tr>
</tbody>
</table>

Table 5 Ten conditions for choosing a knowledge management strategy

6.2.1 PEOPLE

Innovation
Boskalis interviewees think they are pioneers in their industry, but supplying a mature product, scoring 50-50 on the innovation condition. Knowledge transfer is crucial for innovation and innovation is crucial to be a pioneer in the construction industry. For an innovative product, a personalization strategy is more effective to gain new insights. For a more mature product codification is a better approach. So depending on the required knowledge, activities should be adjudged according to its innovatively. All results of the interviewees answers on this condition can be seen in Appendix A.1.1.

Network
96% of the interviewees indicate to have a dense social network through which he can exchange information in an informal way. For organizations with dense social networks, a personalization strategy will be most effective. Knowledge in a personalization strategy cannot be attached from its knowledge-carrier, and employees in an organization with dense social networks like to approach those knowledge carriers. Such a network should be used in the chosen strategy. It should be enlarged and made more easily accessible, in order to be more effective. All results of the interviewees answers on this condition can be seen in Appendix A.1.2

Motivation
Most employees are motivated by an improved organization and personal development, a smaller part (22%) of the interviewees indicted to be motivated by being respected as an expert. Some aspects of a personalization strategy work better for the majority of employees. Such aspects are personal and team development and involving your employees in the successes of the organization. For the 22% which are motivated, a rating system for contributed knowledge to a data system could help to indicated and display how much colleagues appreciate your expertise. All results of the interviewees answers on this condition can be seen in Appendix A.1.3

Attitude
The attitude of Boskalis employees can be characterized as easy going. Only 15% indicated a recognition of aspects of a strict work discipline. Employees in such an organization won’t particularly like a strict, formal and controlled way of knowledge collection, verification, storage, dissemination and reuse; which is more
characteristic of a codification strategy. They can better identify with the informal, personal way of a personalization strategy. All results of the interviewees answers on this condition can be seen in Appendix A.1.4

**Organization**

Boskalis scores around 50-50 on this condition; the organization is local and has an ambition to become more professional. For a professional organization a codification strategy is better suited and for a local organization a personalization strategy is more effective. In a professional organization, a codification strategy can help to improve the knowledge transfer between cooperative departments without requiring a familiarity between employees necessary to ask critical questions and admitting uncertainties. Within departments in a local organization employees are aware who has such knowledge and this knowledge is timely accessible. Other employees are willing to help colleagues and there is enough familiarity and safety within the department to ask for help. Other departments and employees located on projects however should also be included in the knowledge management scope in order to combine knowledge areas.

Since within Boskalis the conditions currently reflect more a local organization, the positive aspects of being familiar with colleagues can be used in a personalization strategy. Having a database often matches the image of employees of a professional organization. This is one reason for an organization which has the ambition to become more professional to choose a codification strategy. Besides a database some more aspects which are of importance to a codification strategy will need to be created in an organization which has the ambition to become more professional. For instance a clear organizational structure, explicit functions and collaboration between departments. All results of the interviewees answers on this condition can be seen in Appendix A.1.5

**Community**

The community in Boskalis is slightly more closed than open. In a closed community employees have a formal way of dealing with each other and will not like to show their uncertainties. People will first try to solve problems themselves before asking for help. In such communities it might help to offer some support without employees having to show their uncertainties. A codification strategy could offer such help. Especially for new employees this would be a help to find the required knowledge and to learn. All results of the interviewees answers on this condition can be seen in Appendix A.1.6

**Sharing**

Most employees prefer sharing tacit knowledge (77%). They highly value the experience of employees, and have little confidence in capturing this knowledge. Tacit to tacit knowledge conversion (socialization) is stimulated in personalization strategies. This creation of new knowledge through socialization can help employees who are retiring to transfer their experiences.

The majority of employees have little confidence in capturing and codifying this knowledge because it has never successfully been done in their organization; employees will put their confidence in such systems once they’ve been proven in practice. Once they’ve been proven and employees are more comfortable with sharing explicit knowledge through externalization and combination codification strategies. All results of the interviewees answers on this condition can be seen in Appendix A.1.7.

**Conclusion on strategies for the people component of knowledge management**

The best course of action for the people component of knowledge management is the personalization strategy. The knowledge management component people indicates how the organization manages, develops and releases the knowledge and full potential of its people at an individual, team-based and organization-wide level. In this case a personalization strategy should focus on:

- Providing instruments to optimize this knowledge creation process required for innovative products.
- Enlarge the dense social network within the organization and make more easily accessible.
- Development of individuals and teams.
• Involving your employees in the successes of the organization.
• Informal, familiar and safe atmosphere at knowledge gatherings.
• Involve other departments in the knowledge management scope.
• Stimulate socialization to create new knowledge.

In this personalization strategy for Boskalis some aspects of codification require focus on:
• Focus on providing instruments to optimize this knowledge creation process required for mature products
• Rating system for contributed knowledge to a data system
• Functions and organizational structure connected to data system
• Help new employees to find the required knowledge and to learn

6.2.2 PROCESSES

Frequency of repeating tasks
The more frequently tasks are repeated in an organization, the more effective a codification strategy. According to the interviewees, 69% of the tasks are frequently repeated; the other 31% of the tasks are infrequently repeated. For the tasks which are frequently repeated, processes can be developed and knowledge about these tasks can be codified. For the other 31% of the tasks, a personalization strategy can help to manage knowledge about these tasks. All results of the interviewees answers on this condition can be seen in Appendix A.1.8.

Willingness to follow processes and protocols
When the way work is done is more important to an organization than what work is done, employees will be happy to follow processes and protocols. However, this is not the case for Boskalis. Employees think what work is done is more important. They are even willing to take some risk while creating the work. Processes are a distraction from this goal. They are seen as time consuming, bureaucratic, twaddle and sometimes even a burden. One interviewee even claimed: “Boskalis employees take pride in being unrestrained and do not have to conform to such rules and processes” (17, 2012).

With little willingness to follow processes it becomes difficult to standardize and control knowledge and make guidelines for knowledge management which are repeatable and comparable. To have a high quality functioning data system you need to have standardizations, guidelines and control mechanisms. Without these it will be hard to implement a codification strategy in such an organization. The personal way of transferring knowledge and validating this knowledge will be much more appealing to employees in such an organization.

Some processes are necessary, as long as they remain practical. Many employees recognize the phenomena of re-inventing the wheel. Processes easily indicated when the wheel is already invented. If you are not willing to follow processes and protocols, personal, informal get-togethers need to be held in order to find out which wheels have been invented and transfer this knowledge to employees who are unaware of the invention. All results of the interviewees answers on this condition can be seen in Appendix A.1.9.

Conclusion on strategies for the process component of knowledge management
The process component determines how the organization designs, manages and improves its processes in order to support its policy and strategy and fully satisfy, and generate increasing value for, its customers and other stakeholders. For this processes component a slight majority of the answers was given support the personalization strategy. The personalization strategy for the process component of knowledge management should focus on:
• Determine which tasks are infrequently repeated and provide means to optimize the knowledge creation process which can help to support these tasks.
• Determine which wheels are frequently reinvented and which employees are unaware of the invention and organize knowledge transfer on these subjects.

Some aspects of codification which would contribute to the knowledge management strategy require focus on:
• Determine which tasks are frequently repeated and develop processes and codify knowledge which can help to support these tasks.

6.2.3 TECHNOLOGY

Cost-efficiency of a database
A majority of the employees would often visit, contribute to and help to maintain a database. Many of these employees would do so considering the database was filled with relevant and interesting information. Also, they would participate assuming they would not have to spend too much time on it and the database is easily accessible. If this is the case, employees would gladly participate in maintaining a database and a codification strategy would be very effective for the organization. Training in efficient use of such databases can make a codification strategy even more effective for the organization.

The other 35% of the employees dislike working with databases and computer systems; regardless of the conditions. For these employees a personalization strategy will be more effective. All results of the interviewees answers on this condition can be seen in Appendix A.1.10.

6.2.4 CONCLUSION

Interviews show that for the ten conditions for selecting a knowledge management strategy, a personalization strategy with some aspects codification would be the most effective knowledge management course for Boskalis. In Figure 15 some results from the interviews are presented. Per condition some questions were asked resulting in the percentages in figure alongside. The percentages relate to answers given by the interviewees for which a personalization or codification strategy is more effective. Some aspects of codification would also be effective when applied in a knowledge management strategy within Boskalis.

Each condition leads to one or multiple requirements for a knowledge management strategy. Emphasis in these requirements lie on a personalization strategy with some aspects of codification. These can be seen in Table 6.
<table>
<thead>
<tr>
<th>Innovation</th>
<th>Personalization</th>
<th>Codification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. Determine which subjects are innovative and</td>
<td>1a. Determine which subjects are</td>
<td>1a. Determine which subjects are</td>
</tr>
<tr>
<td>1b. Facilitate knowledge transfer on this subject.</td>
<td>mature and</td>
<td>mature and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1b. Facilitate knowledge transfer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>on this subject.</td>
</tr>
<tr>
<td>Network</td>
<td>2. Enlarge the dense social network</td>
<td>3e. Rating system for contributed</td>
</tr>
<tr>
<td></td>
<td>within the organization and make more</td>
<td>knowledge to a data system</td>
</tr>
<tr>
<td></td>
<td>easily accessible</td>
<td></td>
</tr>
<tr>
<td>Motivation</td>
<td>3a. Development of individuals and</td>
<td>3a. Development of individuals and</td>
</tr>
<tr>
<td></td>
<td>teams.</td>
<td>teams.</td>
</tr>
<tr>
<td></td>
<td>3b. Involving your employees in the</td>
<td>3b. Involving your employees in the</td>
</tr>
<tr>
<td></td>
<td>successes of the organization</td>
<td>successes of the organization</td>
</tr>
<tr>
<td>Attitude</td>
<td>4. Informal, easy going atmosphere at</td>
<td>5d. Functions and organizational</td>
</tr>
<tr>
<td></td>
<td>knowledge gatherings.</td>
<td>structure connected to data system.</td>
</tr>
<tr>
<td>Organization</td>
<td>5a. Familiar, safe atmosphere at</td>
<td>5a. Familiar, safe atmosphere at</td>
</tr>
<tr>
<td></td>
<td>knowledge gatherings.</td>
<td>knowledge gatherings.</td>
</tr>
<tr>
<td></td>
<td>5b. Involve other departments in</td>
<td>5b. Involve other departments in</td>
</tr>
<tr>
<td></td>
<td>knowledge management scope</td>
<td>knowledge management scope</td>
</tr>
<tr>
<td></td>
<td>5c. Involve projects in the knowledge management scope</td>
<td>5c. Involve projects in the knowledge management scope</td>
</tr>
<tr>
<td>Community</td>
<td>6. Help new employees to find the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>required knowledge and to learn</td>
<td></td>
</tr>
<tr>
<td>Sharing</td>
<td>7a. Stimulate socialization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7b. Transfer of experience of retiring employees</td>
<td></td>
</tr>
<tr>
<td>Frequency of repeating tasks</td>
<td>8a. Determine which tasks are</td>
<td>8a. Determine which tasks are</td>
</tr>
<tr>
<td></td>
<td>infrequently repeated and</td>
<td>frequently repeated and</td>
</tr>
<tr>
<td></td>
<td>8b. Provide means to optimize the</td>
<td>8b. Codify knowledge about these</td>
</tr>
<tr>
<td></td>
<td>knowledge creation process which can</td>
<td>tasks.</td>
</tr>
<tr>
<td></td>
<td>help to support these tasks.</td>
<td></td>
</tr>
<tr>
<td>Willingness to follow processes</td>
<td>9a. Determine which wheels are</td>
<td></td>
</tr>
<tr>
<td></td>
<td>often reinvented, which employees</td>
<td></td>
</tr>
<tr>
<td></td>
<td>are unaware of the invention and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9b. Organize knowledge transfer on</td>
<td></td>
</tr>
<tr>
<td></td>
<td>these subjects.</td>
<td></td>
</tr>
<tr>
<td>Cost-efficiency of a database</td>
<td>10a. Generate high number of users</td>
<td>10a. Generate high number of users</td>
</tr>
<tr>
<td></td>
<td>10b. Have people actively contribute to the database.</td>
<td>10b. Have people actively contribute to the database.</td>
</tr>
<tr>
<td></td>
<td>10c. Have people maintaining the</td>
<td>10c. Have people maintaining the</td>
</tr>
<tr>
<td></td>
<td>database</td>
<td>database</td>
</tr>
<tr>
<td></td>
<td>10d. Make database easily accessible</td>
<td>10d. Make database easily accessible</td>
</tr>
<tr>
<td></td>
<td>10e. Training in efficient use of such databases</td>
<td>10e. Training in efficient use of such databases</td>
</tr>
</tbody>
</table>

Table 6 Requirements for a knowledge management strategy

6.3 REQUIREMENTS FROM PRACTICE

Besides answering questions on the conditions for choosing a knowledge management strategy, the interviewees were also asked what requirements a knowledge management should meet. These requirements were validated during the validation meeting during which some new requirements emerged. Most of these
requirements are a repetition of the requirements distilled from the answers on the ten conditions. The remaining requirements, which have emerged from the previous interview questions, relate to four conditions; motivation, organization, willingness to follow processes and the cost-efficiency of a database.

6.3.1 PEOPLE

Motivation
A majority of the interviewees (73%) believe changes, especially organization wide changes, should be lead by the higher management. Interviewees indicate that for knowledge management to work, the higher management should be on board. Without the management clearly expressing its support for such changes employees do not believe that such things will work and will therefore not be very motivated to contribute.

People would be more motivated to engage in knowledge management when it attains an outcome. One interviewee gave the example of the man-numbers. These man-numbers are an organizational tool for the human resources department. What really worked for those man-numbers to be integrated in the organization was their necessity in archiving projects (23, 2012). So even though few interviewees (25%) indicated being motivated by extrinsically motivation, the motivation of the performance of an activity in order to attain an outcome speaks to their imagination.

Organization
Two extra requirements were mentioned by a number of interviewees which have to do the ambition to become a more professional organization; First of all, Knowledge management should be organization wide implemented. Some interviewees feel that knowledge management has little additional value when it is limited to the department Bebo and should focus on subjects that lead to organization wide advantages.

The second example of wanting more professionalism in the organization is that interviewees indicated that more resources should be made available in the organization. When you want to implement any strategy in an organization, you cannot avoid making resources available. Thus to substantiate this requirement from the interviewees.

6.3.2 PROCESSES

Willingness to follow processes
In the previous section, it already becomes clear that the interviewees are not very interested in following processes. To underline this, a number of interviewees suggested that processes should be loose and that there must be some freedom to make your own choices.

6.3.3 TECHNOLOGY

Cost-efficiency of a database
Finally, systems enabling knowledge management should be linked to other systems. Results should be able to be transported to other systems easily. Eventually, Boskalis systems should even be linked to systems from Boskalis International.
An overview of these requirements suggested by interviewees can be seen in Table 7.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Personalization</th>
<th>Codification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>3c. Management should support KM processes.</td>
<td>5e. The processes should be organization wide implemented</td>
</tr>
<tr>
<td></td>
<td>3d. Engage in knowledge management in order to attain an outcome.</td>
<td>5f. More resources should be made available to implement the processes</td>
</tr>
<tr>
<td>Organization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willingness to follow processes</td>
<td>9c. Loose processes and freedom to make own choices</td>
<td></td>
</tr>
<tr>
<td>Cost-efficiency of a database</td>
<td>10f. Data systems should be linked to other systems</td>
<td></td>
</tr>
</tbody>
</table>

Table 7 Requirements from practice

6.4 CONSTRUCTION INDUSTRY

Interviewees during the external interviews were asked similar question to those asked during the internal interviews at Boskalis on what strategy to implement. Although only one employee per organization was asked these questions, some significant results emerged on what strategies would be most successful for the organization according to that interviewee. Organization 10 can best implement a personalization strategy, organization 14 can best implement a codification strategy and organization 13 had ideas most similar to what Boskalis employees think.

Organization 10 could best implement a personalization strategy, most answers (80%) interviewee 10 gave indicate this. Most notable are the answers on the cost-efficiency of a database within organization 10. Many employees of this organization do not like to work with the available systems. The interviewee created a knowledge matrix with lessons. To make this knowledge matrix usable within the organization the interviewee created it in excel. “An excel sheet is understandable for everybody and it is easy to create” (10, 2012). For such an organization it will be difficult to achieve a critical mass of users for a database, and to have people actively contributing and maintaining the database, and therefore you can wonder whether codifying knowledge has much use for the organization.

Interviewee 14 answers indicate a clear preference for a codification strategy. Besides being the only interviewee indicating a preference towards a codification strategy, organization 14 is the only organization actually implementing a codification strategy. Therefore it is not surprising that this preference follows from the interview questions. What is outstanding, however, is the difference with the replies of the other external interviewees on the condition of willingness to follow processes. Organization 14 is the only organization which had a higher preference to follow processes: “Following processes is more important to reach a certain result. The goal is to deliver projects on time, on budget and safe, it is more important to follow these three things than to deliver the project” (14, 2012).

There answers from interviewee 13 are most similar than those given to Boskalis employees. The maturity level of this organization has been indicated at discovery level. For successful implementation of knowledge management Boskalis can therefore best look at organization 13.
6.5 CONCLUSION

The Boskalis interviewees a preference towards a personalization strategy, with some aspects of a codification strategy. This preference leads to the following requirements for knowledge management within Boskalis:

4. **Requirements for the people component of knowledge management.** A clear determination of innovative and more mature subjects need to made, these require respectively a personalization and a codification approach for knowledge management. The dense social network should be enlarged and be made easier accessible. To do so, management can best, motivate its employees by supporting knowledge management openly, by development of individuals and teams, involving employees in the successes of the organization, making knowledge management activities obligated to attain other outcomes, and creating a rating system for contributed knowledge in a data system. Furthermore, it is important to maintain the easy going and informal atmosphere during at knowledge gatherings. Additionally, it is important for employees to maintain the familiar safe atmosphere while increasing the professionalism of the organization. Finally knowledge management should improve the knowledge transfer between new and experienced employees who are about to leave the organization.

5. **Requirements for the process component of knowledge management.** To improve the effectiveness of knowledge exchanged a determination should be made of which tasks are frequently and which are infrequently repeated. These tasks require respectively a personalization and a codification approach for knowledge management. Also it should be determined which wheels are often reinvented and which interviewees are unaware of these inventions. Furthermore it is important for employees to have loose knowledge management processes with the freedom to make their own choices.

6. **Requirements for the technology component of knowledge management.** In order to make a database effective, a high number of users should be generated, employees have to actively contribute to this database, and people should maintain it. It should be made easily accessible, linked to other systems and employees should be given training in the efficient use of such databases.

Most of the other organizations interviewed indicated a preference towards a personalization strategy. Only one organization indicated a preference towards a codification strategy. The most striking differences between answers from the interviewees if the different organizations occurred for the conditions of willingness to follow processes and cost-efficiency of a database.
7 Design of Solutions for Boskalis

7.1 Introduction

From the requirements distilled from the internal interviews and validated during the validation meeting follow a set of solutions. These solutions are recommendations or advices for Boskalis. It is up to Boskalis to determine how well they think these solutions help to achieve their objectives and how much they are willing to invest in it. These solutions are the second step in the systems engineering process as presented in Chapter 3 – Methodology; the design synthesis. The definition of this process step is according to the US DoD: Design synthesis is the process of defining the product or item in elements which together make up and define the item (2001).

Most effective results will be achieved when implementing all advices. The solutions have been divided in sets of Short-Term, Mid-Term, Long-Term and Very Long-Term solutions. Also the responsibility for different knowledge management activities and the prioritization and risks will be presented. Finally a verification (design loop) of and validation of these solutions will be explained.

7.2 Solutions

A set of solutions or advices was determined to satisfy the requirements. These solutions can be divided in a main solution, short-term solutions, mid-term solutions, long-term solutions and very long-term solutions. The main solution for Boskalis is to implement a personalization strategy towards knowledge management (M). The emphasis in this strategy will lie on managing the knowledge transfer through personal contacts. Some codification activities will take place to support this course of action and to increase the knowledge transfer within the department Bebo (objective 7.02).

Short term solutions can be taken up in the first three months. These are solutions which can support the personalization strategy on the short term and are mainly directed towards increasing the effectiveness of the already available knowledge management means and activities.

Mid-term solutions are the solutions which take 3 months up to a year to implement. These solutions focus on identifying where knowledge is contained within the organization and making this organization wide knowledge available for the department Bebo.

The mid-term solutions are followed by the long-term solutions. When it becomes more clear what knowledge means for an organization like Boskalis, knowledge management processes can be established in order to gain more insight into the achievement of organizational and knowledge management objectives by making the knowledge management process repeatable and the comparable. Implementing long-term solutions takes about a year after successfully implementing the mid-term solutions.
When a foundation is laid for knowledge management within Boskalis very long-term solutions can be looked at. This will be somewhere between two and four years after first taking the personalization course. These include revising the strategy and involving Boskalis International.

All these small solutions over different periods contribute to the adoption of a personalization course of action and the allocation of resources necessary for carrying out long-term objectives for knowledge management in the organization. All these solutions were given a code to identify them and being able to compare them to the set requirements. The main solution is M. Short term solutions start with ST, mid-term solutions with MT. As can be guessed, long term solutions start with LT and very long-term solutions start with VLT.

7.2.1 SHORT TERM

The short-term solutions are solutions which can be achieved in three months time. These solutions are based on existing activities within the organization. The short-term solutions and corresponding codes can be seen in Table 8. In this paragraph, these short-term solutions, sub-solutions and who involved in achieving these solutions will be explained.

<table>
<thead>
<tr>
<th>Code</th>
<th>Short-Term solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-1</td>
<td>Determine long-term objectives for knowledge management to adapt a personalization course of action</td>
</tr>
<tr>
<td>ST-2</td>
<td>Allocation of resources necessary for carrying out the short-term KM objectives</td>
</tr>
<tr>
<td>ST-3</td>
<td>Solve problems with current KM activities</td>
</tr>
<tr>
<td>ST-4</td>
<td>Take down the search time for personal, implicit knowledge</td>
</tr>
</tbody>
</table>

Table 8 Short-Term solutions

1. Determine long-term objectives for knowledge management to adapt a personalization course of action ST-1

In order to implement a strategy, long-term objectives need to be established. This is also the case when implementing a personalization strategy. Long-term objectives need to be established for knowledge management within Boskalis. Objectives can be distilled from these solutions and so can the terms for realizing the objectives. These objectives need to be established by everyone involved in achieving them.

2. Allocation of resources necessary for carrying out these objectives ST-2

Another necessity when implementing a strategy is making resources available for carrying out the objectives. To start, on the short-term it is necessary to make someone responsible and dedicated to knowledge management.

   a. Make someone responsible and dedicated to KM ST-2a

Implementing any knowledge management strategy will stand or fall with making someone responsible and dedicated to knowledge management; a ‘knowledge manager’. Without someone having the overview, is able to spend time on such a method and is responsible for it, implementing any strategy will not lead to successes. During the internal interviews, as well as by the interviewees from external organizations with higher maturity levels, this solution was emphasized.

When selecting someone responsible for knowledge management it is advised to pay attention to selecting someone who has skills in for instance knowledge management or process management. And not only to select someone who fits in the organization or who is currently not engaged elsewhere in the organization. Furthermore that person should care for sharing not only technical knowledge, but also qualitative knowledge. Especially when a new employee is hired to be responsible for knowledge management, it is important for this person to also be (part time) involved in projects. Without this involvement such a person will not get the opportunity to prove itself in the organization and therefore to win the respect of the other employees. Also
due to the local culture it will be difficult for such a person to become integrated in the organizational culture and to determine where which knowledge is available in the organization.

3. Solve problems with current KM activities ST-3
During the internal interviews, interviewees indicated some knowledge management activities and means. These activities and means can become a more successful means to transfer knowledge in the organization and can become part of a strategy for knowledge management when some changes are made; During the interviews employees explained how such activities can lead to more successful knowledge transfer within the organization. Most often mentioned activities are the GROW-cases, meetings, Project End Reports (PERs), evaluations and portals and drives, which will subsequently be discussed.

a. GROW cases ST-3a
The GROW-cases were most often mentioned as activity which had positively contributed to the transfer of knowledge (A3 objective 7.02) and which helped employees to learn how communicate more effectively (A3 objective 7.01). However employees learned how to do this and are ready for the next step in the development of this method within Boskalis. Four sub-solutions for making this method more successful are given.

i. Increase the scope of the GROW cases ST-3ai
Currently the GROW-cases are done only with Bebo employees. This scope should be broadened. Not only will bringing in other people gain new and different views on problems, it will also help to discuss more different topics during the cases and improve collaboration between departments. All Boskalis employees should therefore be involved and included. The participants of GROW-cases cannot be too many. In large groups there is not enough safety, trust and involvement for everyone to have his or her say. A knowledge manager should guard over a maximum number of participants. For instance max 15.

ii. Actively harvesting for subjects ST-3aii
Currently, too little and much of the same subjects are discussed during the GROW-cases. Waiting until employees come up with topics themselves has not been proven successful. Interviews show that this is not due to a lack of necessity to discuss topics, but due to an understanding of which subjects are of interest to discuss, to a lack of time from employees to prepare a GROW-case and to a fear of coming forward with topics. Therefore a knowledge manager should go actively harvesting for subjects. Knowledge mapping as will be discussed further on can also help to determine subjects for GROW-cases

iii. Planning of GROW-cases ST-3aiii
When there are a number of subjects for GROW-cases planned and made known, employees who are interested in discussing such subjects can plan and make time for such GROW-cases. A knowledge manager can coordinate such a planning and can even invite people for whom certain subjects are relevant. If possible, make the GROW-cases exclusive and only invite people for their knowledge.

iv. Disseminate the results throughout the organization ST3aiv
Disseminating the results of GROW-cases throughout the organization can help in the transfer of knowledge and helps employees to feel involved. Therefore a knowledge manager should make notes of the cases and disseminate them throughout the organization. Also implementation of knowledge which is gained should be spread throughout the organization, in order to make employees aware of what is done with their input.

b. Meetings ST-3b
The wet and dry meetings and kick-off were indicated by interviewees during the internal interviews as an important means to transfer knowledge; however, they can lead to more successful knowledge transfers when the following solutions will be considered.

i. Increase the scope of the kick-off meetings ST-3bi
For the start up of a project phase (kick-off) usually a part of a day is planned. During this day part many items are on the agenda such as informing the team, getting acquainted with each other and to do a division of tasks. One day part is too little time to do all of this. On top of that determining the knowledge gaps and organizing knowledge transfer from the previous project phase will not fit within the current time scope of the kick-off meetings.

The kick-off should lose the term meeting. Meeting makes it too formal and limited in time. Depending on the project size the advice is to make the kick-off a day activity. This kick-off should involving informing the team of the project. The team should get acquainted with each other during a social gathering; for instance an informal site-visit. Furthermore sufficient time should be made available to transfer knowledge from previous project phases and to determine the knowledge gaps during this project phase. The tender or project manager is responsible for organizing the kick-off. A knowledge manager can be involved to help organize the determination of the knowledge gaps.

ii. Disseminate the results of meetings throughout the organization ST-3bii
Again, to transfer knowledge and to keep employees involved, results such as notes of kick-off, wet and dry meetings should be disseminated throughout the organization. Responsibility should lie with the person responsible for organizing the meeting.

c. Project End Reports / Evaluations ST-3c
Project End Reports and evaluations are, when they are carried out, only made available to those involved in the project phase. Therefore other employees cannot learn from successes and problems from previous projects.

i. Disseminate the PERs and evaluations throughout the organization ST-3ci
To make such lessons available for the rest of the organization, the PERs and evaluations should be disseminated throughout the organization. The people responsible for the PERs and evaluations should also be responsible for their dissemination throughout the organization.

d. Portals/drives ST-3d
The portals fall under the responsibility of Boskali’s International, therefore Boskali won’t be able to make those more accessible on the short-term. The can do so, however, for their general drive. Three advices are given for this general drive

i. Clean up the General drive ST-3di
There are many folders on the general drive, many of which are unused. Cleaning up this drive will make searching easier. A knowledge manager could be made responsible for this task.

ii. Centrally store all previous mentioned, disseminated documents ST-3dii
Dissemination of the results GROW-cases, meetings, PERs and evaluations creates awareness of the availability of such documents. Centrally storing such documents makes them retrievable when they are deemed necessary. To have an overview and to achieve some standardization, the knowledge manager should be responsible for the central storage of these documents.

4. Reduce the search time for personal, knowledge ST-4
The most practiced form of knowledge transfer is calling someone when you need help. If that someone cannot help, you are redirected. The search time for search such personal knowledge can be reduced.
a. Create linked in-like profiles of employees **ST-4a**
The search time of personal knowledge can be reduced by creating a ‘Boskalis linked-in’. This ‘Boskalis linked-in’ should contain information about the current whereabouts of the employees, their functions, their experiences, their specialties, their contact information and their pictures. Furthermore this linked-in should contain a search function and be up-to-date. In order to achieve a level of standardization and topicality, the knowledge manager should be responsible for filling and maintaining this ‘Boskalis linked-in’

### 7.2.2 Midterm

Mid-term solutions are the solutions which take 3 months up to a year to implement. These solutions focus on identifying where knowledge is contained within the organization and making this organization wide knowledge available for the department Bebo. The mid-term solutions and corresponding codes can be seen in Table 9. In this paragraph, these mid-term solutions, sub-solutions and who involved in achieving these solutions will be explained.

<table>
<thead>
<tr>
<th>Code</th>
<th>Mid-Term solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT-1</td>
<td>Allocation of resources necessary for carrying out the (mid-term) objectives</td>
</tr>
<tr>
<td>MT-2</td>
<td>Knowledge mapping</td>
</tr>
<tr>
<td>MT-3</td>
<td>Make organizational structure and responsibilities clearer</td>
</tr>
<tr>
<td>MT-4</td>
<td>Knowledge transfer from new to mature employees</td>
</tr>
<tr>
<td>MT-5</td>
<td>Knowledge transfer from tender to execution phase</td>
</tr>
<tr>
<td>MT-6</td>
<td>Knowledge transfer between departments</td>
</tr>
<tr>
<td>MT-7</td>
<td>Portals/drive</td>
</tr>
</tbody>
</table>

**Table 9 Mid-Term solutions**

1. **Allocation of resources necessary for carrying out these objectives MT-1**

Continuing during the mid-term an allocation of resources is necessary for implementing a personalization strategy. As could be seen in the previous paragraph and in Table 12, in the short term, many responsibilities lie with the knowledge manager. In the mid-term more input will be required from the employees.

   a. Invest some working hours in employees for knowledge management activities. **MT-1a**

   Since the knowledge lies with the employees, some of their work time needs to be made available to identify this knowledge and make it organization wide available. Management is the responsible party for making this time available.

2. **Knowledge mapping MT-2**

For the organization it is important where its knowledge is and how it should be shared. To identify this knowledge it needs to be ‘mapped’.

   a. Learn people what knowledge is important to share/transfer **MT-2a**

   Boskalis employees love to think in technological solutions and to share knowledge on such subjects. The qualitative subjects can get under-exposed. Therefore they need to determine which knowledge subjects are required for the tender process (a specification of the subjects as presented in paragraph 5.2.2 – Subjects of knowledge). And which of these subjects are innovative and which are mature. Which tasks are frequently repeated and which are infrequently repeated and which wheels are often re-invented. Innovative subjects and infrequently repeated tasks can be discussed during GROW-cases (as were mentioned in the previous paragraph, ST-3aii) and Communities of Practice (CoPs) as will be discussed further on in this paragraph (MT-5b). A knowledge manager will be responsible for organizing and leading such knowledge mapping meetings and employees will be responsible for giving input during these meetings.

   b. Training people how to share knowledge **MT-2b**
Training in identifying the problem and thinking of implementation issues. The issue is often not only due to technology, but also often to people or to processes. The survey 2015 project is a good example of such a training which can also be applied by the rest of the organization. Someone able to lead such training should manage these training and employees should provide input and learn.

3. Make organizational structure and responsibilities more clear MT-3
Making the organizational structure and responsibilities more clear influences a number of issues. First, it will help with becoming more professional as organization. Explicit specialized functions will help the cooperation between the departments. Furthermore it is more clear who is responsible, so who to search for. It will be a help for the ‘Boskalis linked-in’ (ST-4a). Also it will be helpful to determine which knowledge to distribute to who and who should be invited to which meeting. The management is responsible for creating an organizational structure and responsibilities. The knowledge manager is responsible for implementing this into knowledge management means such as the ‘Boskalis linked-in’.

4. Knowledge transfer from new to mature employees MT-4
The knowledge transfer from new to mature employees can be improved. For new employees there are some difficulties in finding the required knowledge and when mature employees leave the organization, their knowledge vanishes with them. Three advices have been formulated which can help to transfer knowledge between these two groups of employees.

a. Make a ‘welcome document’ for new employees MT-4a
A ‘welcome document’ can introduce new employees to the Boskalis way of working and how to gather knowledge in the organization. Such a document should contain some basic start-up information, for instance how to install a printer or what everyone does for lunch. Furthermore it should contain information about the organizational culture and how employees deal with each other and information on how to find and share knowledge in the organization. The HR department together with the help of the knowledge manager could create such a document.

b. Video clips MT-4b
Video clips can help to make certain practices in the organization explicit without the need to engage in time consuming bureaucratic documentation. Also they can easily be accessed by new employees without the need to justify the search for this knowledge. Frequently repeated tasks, determined during knowledge mapping (MT-2a) can be documented this way. Also resigning employees can be asked to document knowledge in such a way. Employees need to tape such films, which can even be done during work and with more people. The knowledge manager can be in charge of instructing, storing, editing and standardizing such videos. The storage medium for these videos needs to have a search function.

c. Oeuvre meetings MT-4c
During an oeuvre meeting, an employee can give a ‘final presentation’ on the whole of the work that he has produced during his career at Boskalis. Putting such an employee on a pedestal enables him to feel empowered and tell about his experiences within the organization. He can tell about do’s and don’ts or about some specific events. People who can learn from him can be invited. Inviting only certain people will make such a meeting even more about the resigning employee. The knowledge manager can help the resigning employee to organize the meeting, while colleagues need to give filling to the meeting.

5. Knowledge transfer from tender to execution phase MT-5
The knowledge transfer from the tender to the execution phase of projects and vice versa can be improved. Improvements on the kick-offs of each projects phases, as were recommended under the short term solutions (ST-3bi), will make a start in improving the knowledge transfer between project phases. Two further improvements will be recommended for the mid-term.
a. Document (production) data MT-5a
Some data about products can be documented in order for employees to take this along during other project phases. This is data about preferred vendors and production data. Employees need to give the input while the knowledge manager can supply the documentation.
   i. Preferred vendor list MT-5ai
   ii. Production data MT-5a(ii)

b. Communities of practice MT-5b
Communities of Practice (CoPs) are a group of people informally bound together by shared experience. CoPs stretch across divisional boundaries and aim at developing members’ capabilities and creating and exchange knowledge. Such CoPs should get together once every quarter for about an hour to discuss knowledge gaps on their shared experience. CoPs have a high level of self organization, so even more meetings can be planned or a portal can be erected when the groups deems it necessary. A knowledge manager should facilitate such meetings while employees should give input to them. Examples of CoPs which could be formed within Boskalis are project/tender management, wet and dry, MEAT and contract management.

6. Knowledge transfer between departments MT-6
The knowledge transfer between the departments can be improved. An improvement of knowledge transfer between departments will also improve the collaboration between departments. Two solutions are given to improve this transfer of knowledge between departments.

a. Inter-department trainings MT-6a
Training is in itself valuable to the organization. Employees will gain knowledge and learn new skills. Furthermore Boskalis employees are motivated by personal development, so trainings can add to the work atmosphere. Inter-departmental training will take employees out of their working environment and will be a good environment to get acquainted with employees from other departments and (establish a basis to) transfer knowledge. Management should make resources available and determine which training is useful for the organization. Employees should

b. Involve employees from different departments in KM activities MT-6b
A number of activities were already advised to increase knowledge transfer within the organization. In order to increase the knowledge transfer between departments, other departments can be involved in some knowledge management activities; for instance CoPs, Oeuvre meetings, video clips, the Boskalis linked-in, and GROW-cases.

7. Portals/drive MT-7
Some employees have difficulties working with the portals and drives. A refreshment course could help them become better familiar with such environments and to become more eager to work with such means. The IT departments should facilitate such courses and employees need to participate in them.

a. Refreshment course portals MT-7a

7.2.3 LONG-TERM
Long-Term solutions take about a year to implement after successfully implementing the mid-term solutions. These solutions have to do with establishing knowledge management in processes. The long-term solutions and corresponding codes can be seen in Table 10. In this paragraph, these long-term solutions, sub-solutions and who involved in achieving these solutions will be explained.

<table>
<thead>
<tr>
<th>Code</th>
<th>Long-Term solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT-1</td>
<td>Allocation of resources necessary for carrying out the (long-term) objectives</td>
</tr>
</tbody>
</table>
1. **Allocation of resources necessary for carrying out the objectives LT-1**
   a. **Make some resources available for developing a data system LT-1a**
   The development of improvement of systems such as portals requires some resources, expertise knowledge and the involvement of Boskalis international. Starting improvements on the portal or on a new data system is planned for the very-long term, but because making resources available will take some time, this process should start before the actual development of those systems. Management is responsible for making resources available and involving Boskalis International.

2. **Knowledge management process LT-2**
To make knowledge management repeatable, comparable, and give insights in reaching the objectives, knowledge management process in guidelines. Boskalis employees indicated to have little willingness to follow processes. Only processes are tolerated when it helps to not do things over, to have a line in your work and to demonstrate what success following such a process brings. Just that is the reason for a knowledge management process to need be established in guidelines. Without guidelines it will be very difficult to determine the contribution of knowledge management. These guidelines need to be loose in order to create willingness to follow them. Furthermore processes are to some employees important for becoming more professional as organization.

   a. **Establish KM process in guidelines LT-2a**
   The knowledge management process needs to be established in guidelines. Steps need to be determined when to apply certain knowledge management activities and how to apply them during the project. An example is establishing the determination of knowledge gaps at the beginning of each project phase. This needs to be established in the WIT and in the KAM process documents. Responsible for establishing these processes should be a process manager and the knowledge manager.

   b. **Make those guidelines repeatable LT-2b**
   Such guidelines should be made repeatable. Only when repeating process steps are repeated they can be compared. A process manager should be responsible for repeating process steps which are necessary for projects.

   c. **Make those guidelines comparable LT-2c**
   When process steps are repeated and standardized they can be compared. For instance when evaluations are done after each project phase, and these are standardized in format, but even in on some subjects, then these can be compared and you can learn as an organization from those evaluations. A knowledge manager should be responsible for standardizing the outcomes of knowledge management activities while a process manager should be responsible for comparing process steps and acting on the results.

   d. **Connect such guidelines to organizational goals LT-2d**
   Such repeated and compared processes can now help to give insights into achievement of organizational goals and adjusting courses of action. A process manager should do this for organizational objectives and the knowledge manager for knowledge management objectives as were established in the short term solutions (ST-1).

### 7.2.4 Very-long term
The very long term starts after the long-term, when the objectives for the course of action are achieved. On the very long-term the conditions for choosing a knowledge management need to be reviewed. Two very long-term solutions can be seen in Table 11.
<table>
<thead>
<tr>
<th>Code</th>
<th>Very Long-Term solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLT-1</td>
<td>New network data system/improve portals</td>
</tr>
<tr>
<td>VLT-2</td>
<td>Review the conditions for choosing a strategy and set out a new strategy</td>
</tr>
</tbody>
</table>

### 1. New network data system/improve portals VLT-1

When comparison of processes (LT-3) and a review of the conditions for choosing a strategy (VLT-2) show the need to improve the portals or implement a new system, and when resources have been made available (LT-1a), improvements on the data system can start. Someone with expert knowledge should be involved in creating this data system and all employees should be able to set requirements for such a system.

### 2. Review the conditions for choosing a strategy and set out a new strategy VLT-2

After achieving the objectives, things will have changed in the organization. People’s mindset towards knowledge exchange will have changed, the organization will have achieved a higher maturity level and new objectives need to be determined. This asks for a revision of the conditions for choosing a strategy and setting out a new strategy. When setting out a new (knowledge management) strategy, the strategy cycle for short-term, mid-term, long-term and very-long-term solutions will be repeated. This cycle can be seen in Figure 16. Everyone in the organization is responsible for giving input to setting out a new strategy.

### 7.3 Responsibility

The responsibility for the different solutions was already discussed in the previous paragraph. In Table 12 an overview of the responsibility for different activities can be seen. Everybody, which would be all Boskalis employees, their main responsibility during knowledge management activities is to participate and give input. Management is responsible for supporting those activities, a commitment to a long-term dedication to knowledge management and making resources available. A knowledge manager has many responsibilities, which mainly have to do with facilitating knowledge management activities. This list of activities the knowledge manager is responsible for substantiates the solution (ST-2a) to make someone responsible and dedicated to knowledge management. Next there is a process manager who is responsible for establishing knowledge management in the organizational processes and finally there are some other employees and departments responsible for some knowledge management activities.

<table>
<thead>
<tr>
<th>Applicable to</th>
<th>Code</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Everybody</td>
<td>ST-1</td>
<td>Determine long-term objectives for knowledge management</td>
</tr>
<tr>
<td></td>
<td>ST-3ai</td>
<td>Involved and included in GROW-cases</td>
</tr>
<tr>
<td></td>
<td>MT-2a</td>
<td>Giving input during knowledge mapping meetings</td>
</tr>
<tr>
<td></td>
<td>MT-2b</td>
<td>Training on how to share knowledge</td>
</tr>
<tr>
<td></td>
<td>MT-4b</td>
<td>Tape video clips</td>
</tr>
<tr>
<td></td>
<td>MT-4c</td>
<td>Participate in oeuvre meetings</td>
</tr>
<tr>
<td></td>
<td>MT-5a</td>
<td>Give input to the documentation of production data from project phases</td>
</tr>
<tr>
<td></td>
<td>MT-5b</td>
<td>Give input to CoPs</td>
</tr>
<tr>
<td></td>
<td>MT-6a</td>
<td>Participate in (inter-departmental) training</td>
</tr>
<tr>
<td></td>
<td>MT-7a</td>
<td>Participate in refreshment course for the portals</td>
</tr>
<tr>
<td></td>
<td>VLT-1</td>
<td>Set requirements for improved data system</td>
</tr>
<tr>
<td></td>
<td>VLT-2</td>
<td>Give input to setting out a new strategy</td>
</tr>
<tr>
<td>Management</td>
<td>ST-2a</td>
<td>Make someone responsible and dedicated to knowledge management</td>
</tr>
<tr>
<td></td>
<td>ST-3bii</td>
<td>Disseminate the results of meetings throughout the organization</td>
</tr>
</tbody>
</table>
MT-1a  Making time available for employees to engage in knowledge management activities
MT-3  Making organizational structure and responsibilities clear
MT-6a  Make resources available and determine which (inter-departmental) training are useful for the organization
LT-1a  Make resources available for developing a data system

Knowledge Manager
ST-3ai  Guard the maximum number of participants of GROW-cases
ST-3aii  Actively harvesting for subjects for GROW-cases
ST-3aiii  Coordinate planning of GROW-cases
ST3-aiiv  Make notes of GROW-cases and implementation and disseminate throughout the organization
ST-3bi  Help to determine the knowledge gaps at the beginning of a project phase
ST-3di  Clean up general drive
ST-3dii  Store results of GROW-cases, meetings, PERs and evaluations on general drive
ST-4a  Fill and maintain ‘Boskalis linked-in’
MT-2a  Organizing and leading knowledge mapping meetings
MT-2b  Organize and lead knowledge sharing training
MT-3  Implementing organizational structure in knowledge management means
MT-4a  Make a ‘welcome document’ for new employees
MT-4b  Instructing, storing, editing and standardizing such videos
MT-4c  Help to organize ouevre meeting
MT-5a  Document of production data from project phases (preferred vendor list, production data)
MT-5b  Facilitate CoPs
LT-2a  Establish knowledge management in processes
LT-2c  Standardize outcomes of knowledge management steps
LT-2d  Give insights into achieve organizational goals and adjusting courses of action.

Tender/project manager
ST-3bi  Organize kick-off
ST-3ci  Dissemination of Project End Reports and evaluations

HR department
MT-4a  Make a ‘welcome document’ for new employees

IT department
MT-7a  Refreshment course on the use of portals

Expert (IT department)
VLT-1  Improve data system

Process manager
LT-2a  Establish knowledge management in processes
LT-2b  Repetition of process guidelines
LT-2c  Compare process steps
LT-2d  Give insights into achieve organizational goals and adjusting courses of action.

Table 12 Responsibility for different knowledge management solutions

7.4  PRIORITIZATION AND RISKS

The solutions and responsibilities as presented in the previous paragraphs are an advice for Boskalis. It is up to them to choose which solutions to implement. However some solutions are more crucial to implement for the strategy. Therefore a prioritization of solutions and the risks for which the advice will not provide the intended results will be presented in this paragraph.
Most crucial for implementing a strategy are the long-term objectives of an organization, the adoption of courses of action and the allocation of resources necessary for carrying out these objectives. Not implementing such solutions will have a large impact on the successful implementation of a strategy. These crucial factors are not only what will break the strategy, but also what will make it. Implementing a knowledge management strategy in Boskalis the crucial importance of solutions entails:

- (Very) long-term dedication to knowledge management (ST, MT, LT & VLT)
- Setting objectives for knowledge management (ST-1)
- Adopting a personalization course of action (M)
- The allocation of resources (ST-2, MT-1, LT-1)

All of these important solutions fall under the responsibility of management. Therefore it can be said that without management support knowledge management will not be successful within Boskalis. For example this has also been a success factor in the implementation of NINA as was explained in paragraph 4.4. Management support and dedication are the last crucial factor for successfully implementing a knowledge management strategy in the organization.

The impact of not implementing these solutions will contribute to a significant risk of the solutions not leading to the intended results. A risk is an uncertain event which has a chance of occurrence and an impact on the outcome of this event (Project Management Institute, 2000). In this case a risk is perceived as a threat to the successful implementation of the knowledge management strategy within Boskalis. For the solutions risks events have been determined There are two categories of risks; Internal risks, coming from within the organization Boskalis; and external risks, coming from the outside of Boskalis. Every risk event occurs because of a cause and will have a potential effect on the intended result of the proposed knowledge management strategy solutions. In combination with the chance of occurrence and impact of the event, the risk for this event can be determined.

The chance of occurrence and impact of an event were determined from a five-point scale, while the risks were ranked from low to high. This can be seen in Table 13. In this table attention was paid to the more crucial risks (only high and medium risks) which threaten the knowledge management (strategy).

<table>
<thead>
<tr>
<th>Cause</th>
<th>Event</th>
<th>Consequence</th>
<th>Chance of occurrence</th>
<th>Impact</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal risks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal oriented culture</td>
<td>Advice is not interpreted</td>
<td>No Management of Knowledge</td>
<td>2</td>
<td>5</td>
<td>High</td>
</tr>
<tr>
<td>Not setting objectives for KM</td>
<td>No adoption of courses of action or allocation of resources necessary for carrying out these objectives</td>
<td>No KM strategy</td>
<td>2</td>
<td>4</td>
<td>Medium</td>
</tr>
<tr>
<td>No sufficient allocation of resources</td>
<td>No one made responsible and dedicated to KM</td>
<td>No facilitation of KM</td>
<td>3</td>
<td>4</td>
<td>High</td>
</tr>
<tr>
<td>No sufficient allocation of resources</td>
<td>'Knowledge manager' too engaged in project work</td>
<td>No facilitation of KM</td>
<td>4</td>
<td>3</td>
<td>High</td>
</tr>
<tr>
<td>No sufficient allocation of resources</td>
<td>No investment in employees working hours for KM activities</td>
<td>No participation and input for KM</td>
<td>2</td>
<td>4</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Page | 73
No sufficient allocation of resources | No allocation of resources made available for development of systems | No KM strategy | 3 | 2 | Medium
Not adopting a course of action for KM | No focus on personalization | No KM strategy | 2 | 4 | Medium
Short term thinking | Premature truncation of strategy if it doesn’t show evident results on the short term | Truncation of KM strategy | 4 | 3 | High
Organizational objectives not made comparable | No determination of contribution of knowledge management | Less motivation to continue in managing knowledge | 4 | 2 | Medium
Integration with MNO Vervat | Internal organizational changes | Change in required knowledge for Bebo | 3 | 2 | Medium
Integration with MNO Vervat | Change in people, processes and technologies | Different strategy required | 2 | 4 | Medium
Large personnel flow | New management with new objectives | No KM strategy | 2 | 4 | Medium
External risks
Change of policy from Boskalis International | Changes in available activities and means | Change in current KM activities | 4 | 2 | Medium
External change in tender process | Less emphasis on MEAT scores | Less external drive to continue in KM | 2 | 3 | Medium

Table 13 Risks for the Knowledge Management solutions within Boskalis

These risks are determined to give Boskalis insights in what will happen when they will not implement the solutions as proposed. Therefore they are the risk owners and responsible for mitigating these risks.

7.5 DESIGN LOOP

The requirements which were set in Chapter 6, need to be processed in order to ensure that the solutions are correct. In the in the US DoD systems engineering process (2001) this is called the design loop. The design loop is the process of revisiting the design to verify whether it can perform the requirements. The design loop helps to determine helps optimize the synthesized design.

Each solution should satisfy a requirement. After the solutions were designed for the set requirements, they were compared to validate whether all requirements were satisfied with a solution. The requirements, and the corresponding, satisfying solutions can be seen Table 14. As can be seen, all requirements are satisfied by the solutions.
<table>
<thead>
<tr>
<th></th>
<th><strong>Important to share/transfer</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1b</td>
<td>Organize knowledge transfer on these subjects.</td>
</tr>
<tr>
<td>2</td>
<td>Enlarge the dense social network within the organization and make more easily accessible</td>
</tr>
<tr>
<td>3a</td>
<td>Development of individuals and teams</td>
</tr>
<tr>
<td>3b</td>
<td>Involving your employees in the successes of the organization</td>
</tr>
<tr>
<td>3c</td>
<td>Management should support KM processes</td>
</tr>
<tr>
<td>3d</td>
<td>Engage in knowledge management in order to attain an outcome</td>
</tr>
<tr>
<td>3e</td>
<td>Rating system for contributed knowledge to a data system</td>
</tr>
<tr>
<td>4</td>
<td>Informal, easy going atmosphere at knowledge gatherings</td>
</tr>
<tr>
<td>5a</td>
<td>Familiar, safe atmosphere at knowledge gatherings</td>
</tr>
<tr>
<td>5b</td>
<td>Involve other departments in knowledge management scope</td>
</tr>
<tr>
<td>5c</td>
<td>Involve projects phases in the knowledge management scope</td>
</tr>
<tr>
<td>5d</td>
<td>Functions and organizational structure connected to data system</td>
</tr>
<tr>
<td>5e</td>
<td>The processes should be organization wide implemented</td>
</tr>
<tr>
<td>5f</td>
<td>More resources should be made available to implement the processes</td>
</tr>
<tr>
<td>6</td>
<td>Help new employees to find the required knowledge and to learn</td>
</tr>
<tr>
<td>7a</td>
<td>Stimulate socialization</td>
</tr>
<tr>
<td>7b</td>
<td>Transfer of experience of retiring employees</td>
</tr>
<tr>
<td>8a</td>
<td>Determine which tasks are frequently and which are infrequently repeated</td>
</tr>
<tr>
<td>8b</td>
<td>Organize knowledge transfer on these subjects</td>
</tr>
</tbody>
</table>
7.6 **Validation**

Besides satisfying the requirements, it is important that the solutions help to achieve what Boskalis wants to achieve (whether the correct solutions have been designed). To validate the solutions for Boskalis it is important to determine if and how the knowledge management strategy leads to the intended results in case all risks as presented in paragraph 7.4 have been mitigated. In Chapter 4, the mission and some objectives of department Bebo were discussed. These are:

**Mission**
The organizational bureau of Boskalis NL (Bebo) ensures – as heart and head of the organization – the continuity of operations through which Boskalis NL can optimally achieve its objective.

**Objectives**

6.02 In 2012 will Boskalis obtain an average of at least 75% of the MEAT score
7.01 The score on effective communication within Bebo increased from a 6,3 in 2011 to a 7,6 in 2012 on a ten-point scale
7.02 The score (on a 10-point scale) for knowledge transfer within the department Bebo will be increased from a 5.5 in 2011 to 7.1 in 2012.
7.03 The score on a ten-point scale on collaboration increased from a 6,8 in 2011 to an 8,0 in 2012

To start with **objective 7.02, the increase of the transfer within department Bebo**. Knowledge management of Boskalis is at the initial maturity level for knowledge management. Knowledge management is the systematic and organized process of acquiring, organizing and communicating knowledge in order to create new knowledge, to distribute knowledge to people who require it, to make knowledge accessible for future use, to combine knowledge areas and to make knowledge collectively accessible. By implementing a knowledge management strategy and solutions like making someone responsible for knowledge management, setting knowledge management objectives and establishing the knowledge management process in guidelines,
Boskalis will become more mature in its knowledge management and become more systematic and organized in acquiring, organizing and communicating knowledge in order to increase the knowledge transfer within the department Bebo.

Secondly the objective 6.02, the increase of the average MEAT scores. As was explained in paragraph 4.5.2, the most influenceable success criterion for winning a tender is achieving the highest possible MEAT score. Mapping knowledge (MT-2) is important to determine which knowledge is important to the tender process and further adoption of the knowledge management strategy will help to create new knowledge, to distribute knowledge to people who require it, to combine knowledge areas and to make knowledge collectively accessible on these subjects in order to achieve a higher MEAT score. Achieving higher MEAT scores will in itself influence the probability of winning the tender which will lead to higher tender success rate (objectives 9.06, 9.07, 9.08).

Furthermore objective 7.01, improved communication. Communication is an important means to transfer knowledge. By improving communication, the knowledge transfer will be improved. For example, by learning what knowledge is important to share (MT-2), it will be easier to communicate the required knowledge. Reducing the search time for personal knowledge (ST-4) leads more easily accessible knowledge and less frustration in communication. And improving the knowledge transfer from new to mature employees (MT-4) leads to more confidence in communication.

Finally objective 7.03, improved collaboration. For effective collaboration it is, amongst things, necessary to have clear communication, trust between team members, openness to talk about performance and conflicts and team members feeling part of the team (Schoenmaker & Laudy, 2012). This is also relevant for effective knowledge transfer in the organization. How knowledge management contributes to improved communication has been explained in the previous section. Furthermore the personalization strategy (M) endorses an environment in which there is an informal, easy going, familiar and safe atmosphere to transfer knowledge. Also the solutions for knowledge transfer between tender and execution phase (MT-5) and between departments (MT-6) help team members from any part of the organization to become more familiar and feeling part of a team.

All of this adds to achieving Boskalis mission to ensure the continuity of operations through which Boskalis can optimally achieve its objective.

7.7 Conclusion

A set of short-term, mid-term, long-term and very long-term solutions have been designed in order to achieve the main advice for Boskalis: To implement a personalization strategy towards knowledge management. These solutions can be seen in Table 15.

<table>
<thead>
<tr>
<th>Code</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Implement a personalization strategy towards knowledge management</td>
</tr>
<tr>
<td>ST-1</td>
<td>Determine long-term objectives for knowledge management</td>
</tr>
<tr>
<td>ST-2</td>
<td>Allocation of resources necessary for carrying out the KM objectives</td>
</tr>
<tr>
<td>ST-3</td>
<td>Solve problems with current KM activities</td>
</tr>
<tr>
<td>ST-4</td>
<td>Take down the search time for personal, implicit knowledge</td>
</tr>
<tr>
<td>MT-1</td>
<td>Allocation of resources necessary for carrying out the (mid-term) objectives</td>
</tr>
<tr>
<td>MT-2</td>
<td>Knowledge mapping</td>
</tr>
<tr>
<td>MT-3</td>
<td>Make organizational structure and responsibilities clearer</td>
</tr>
<tr>
<td>MT-4</td>
<td>Knowledge transfer from new to mature employees</td>
</tr>
<tr>
<td>MT-5</td>
<td>Knowledge transfer from tender to execution phase</td>
</tr>
</tbody>
</table>
In the responsibility for knowledge management activities, three important groups can be identified. The employees who are responsible for participating in and give input to the knowledge management activities. The management, who is responsible for supporting and making resources available for the activities and a ‘knowledge manager’ who is responsible for facilitating knowledge management activities within the organization.

Without these responsibilities and allocation of other resources, no successful implementation of a knowledge management strategy is possible. Other crucial factors for successful implementing a knowledge management strategy within Boskalis are adopting a personalization course of action for which objectives for knowledge management are set and a long-term dedication; especially by the higher management, to this course of action.

Finally the solutions have been verified to ensure that the solutions are correct and satisfy all requirements. Also they have been validated to ensure that the correct solutions have been design which helps the department Bebo to ensure continuity of operations through achieving an increased knowledge transfer, a higher average on MEAT scores and more effective communication and collaboration.
8 CONCLUSION

8.1 CONCLUSION

Under which conditions can which Knowledge Management Strategy help Boskalis to become more successful in the tender phase of projects in the construction industry?

The answer to this research question is after reviewing the ten conditions for selecting a knowledge management strategy, it can be concluded that Boskalis will gain the most advantage in implementing a personalization strategy. Implementing such a strategy will help the department Bebo to ensure continuity of operations through achieving an increased knowledge transfer, a higher average on MEAT scores and more effective communication and collaboration.

More elaborate answers to the sub-questions below will be presented in this paragraph.

1. What are theories on knowledge management?
   a. What is knowledge management?
   b. What are knowledge management strategies for project-based organizations?
   c. What are conditions for selecting a knowledge management strategy?
   d. What is the role of project-based organizations in the construction industry?
2. What is the current situation of knowledge management at a project-based organization in the construction industry?
   a. What are the characteristics in the case of Boskalis: a project-based organization in the Dutch construction industry?
   b. What is a successful tender phase?
   c. What are elements of the current knowledge management process at Boskalis?
   d. What is the current situation in other project-based organizations in the Dutch construction industry?
3. How can a design be made a knowledge management strategy for the case?
   a. What are requirements for a knowledge management strategy for Boskalis?
   b. What strategy should Boskalis deploy?
   c. How should this be implemented at Boskalis?
4. What is the generic application of knowledge management for PBO’s in the construction industry?
   a. Which aspects are of value to the industry?

Knowledge management

There are two types of knowledge; tacit knowledge and explicit knowledge. Tacit knowledge is personal, implicit knowledge while explicit knowledge is easy to codify and can be easily detached from its carrier. New knowledge can be created through knowledge conversion of these types of knowledge. Knowledge management is the systematic and organized process of acquiring, organizing and communicating tacit and explicit knowledge in order to create new knowledge, to distribute knowledge to people who require it, to make knowledge accessible for future use. The degree of maturity of knowledge management in your organization can be indicated by determining the maturity level of your knowledge management activities. There are five levels of maturity in knowledge management: the initial level, the knowledge discovery level, the knowledge creation level, the knowledge manager level and the knowledge renewal level.
Knowledge management strategies

A knowledge management strategy engages in the determination of long-term goals and objectives for knowledge management, and the adoption of courses of action and the allocation of resources necessary for carrying out these knowledge management objectives. There are two courses of action to be taken when implementing a knowledge management strategy in a project-based organization in the construction industry; a personalization strategy or a codification strategy. A personalization strategy focuses on the flow of tacit knowledge through personal contacts and the improvement of a professional organization based on criteria of human behaviour and the cultural context thereof. In a codification strategy knowledge can be analyzed independently of its carriers and explicit knowledge is transferred to information which can be stored in database and made accessible to all company personnel.

Conditions for selecting a knowledge management strategy

There are ten conditions for selecting a knowledge management strategy. Per condition there is a reason why selecting the one course of action is most effective for your organization. These can be seen in the table below:

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Personalization</th>
<th>Codification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Innovation</td>
<td>Innovative product</td>
<td>Mature product</td>
</tr>
<tr>
<td>2. Networks</td>
<td>Informal, dense social network</td>
<td>Formal network of databases</td>
</tr>
<tr>
<td>3. Motivation</td>
<td>Improved rep organization &amp; personal development</td>
<td>Being respected as expert by colleagues</td>
</tr>
<tr>
<td>4. Attitude</td>
<td>Easy going work discipline</td>
<td>Strict work discipline</td>
</tr>
<tr>
<td>5. Organization</td>
<td>Local, flat organization</td>
<td>Professional, layered organization</td>
</tr>
<tr>
<td>6. Community</td>
<td>Open system</td>
<td>Closed system</td>
</tr>
<tr>
<td>7. Sharing</td>
<td>Ambiguous, tacit knowledge</td>
<td>Explicit knowledge</td>
</tr>
<tr>
<td>8. Frequency of repeating tasks</td>
<td>Infrequent repetition</td>
<td>Frequent repetition</td>
</tr>
<tr>
<td>9. Willingness to follow processes and protocols</td>
<td>Goal oriented</td>
<td>Means oriented</td>
</tr>
<tr>
<td>10. Cost-efficiency of a database</td>
<td>Inefficient</td>
<td>Efficient</td>
</tr>
</tbody>
</table>

Table 16 Conditions for selecting a knowledge management strategy

Role of project-based organizations in the construction industry

Organizations in the construction industry are characterized by work oriented towards projects. Some features of this work are multi-disciplinary teamwork, continuous and discontinuous change, enhanced networking with customers and suppliers, customer orientation, multi-disciplinary and cross functional cooperation and very little emphasis in issues such as the organizational structure. The organizations in the construction industry are involved in engineering, procuring and building constructions. Tendering is the bidding process of the procurement. There are two award criteria for competitive bidding in the construction industry; the lowest price and the Most Economically Advantageous Tender (MEAT). For this last award criterion more criteria will be considered than just the price. This MEAT criterion causes project-based organizations in the construction industry to have a different approach to the tender process then for lowest price award criteria.

Boskalis, a project-based organization in the Dutch construction industry

Boskalis is an organization which has been active in the construction industry for over a hundred years. All of these years experience, successes and difficulties, operating in national and international markets have made the organization to what it is today. Its culture can be described as goal oriented, externally driven, with an easy going work discipline, a masculine, closed system and an orientation towards work. Furthermore Boskalis organizational culture can be described as local with familiar aspects, but with an ambition to become more professional.
Types of projects in the construction industry Boskalis is involved in are the construction of embankments for infrastructure, dredging, dike reinforcements, coastal and underwater nourishments, maintenance of waterways, soil analysis and remediation, nature development, preparation of construction sites and land reclamation. Their organizational structure is mainly organized around these projects.

The department Bebo is responsible for obtaining projects by participating in tenders. This department formulated a document of objectives called the A3. One of the objectives is to increase the knowledge transfer within the department Bebo. Other objectives deal with becoming more successful in tenders.

**Successful tender phase**
The Work Instruction Tenders (WIT) provides descriptions for the generic steps that are should be completed within a tender process. This tender process is successful for the Boskalis when:

1. Boskalis wins the tender
2. For the highest possible bidding price
3. And the highest possible MEAT score
4. When the distance to the price of the number 2 is as small as possible
5. While a realistic price is offered

The internal factors of the competitive bidding process can be influenced by the organization itself. The criteria which are most dependant on internal factors and on which the organization can exert most influence are the third and fifth success criteria; achieving a high MEAT score and offering a realistic price.

**Current knowledge management activities at Boskalis**
Knowledge which is important in the organization is practical knowledge and experience on technological subjects. Employees care for sharing such knowledge but care less for sharing qualitative knowledge. Within Boskalis qualitative knowledge is all knowledge required for doing tenders which has a non-technical knowledge. This knowledge is also important to the organization however, employees care less for sharing such knowledge. When a knowledge sharing occurs, it is transferred within departments, but knowledge transfer between departments, between project phases and between new and experienced employees can be improved.

In managing this knowledge, Boskalis has achieved the initial maturity level of knowledge management. At this maturity level knowledge management activities are ad hoc; little is standardized, comparable and repeatable. Examples of knowledge management activities within Boskalis are person-to-person communication, meetings, GROW-cases and portals.

Furthermore there are no long-term goals and objectives for the management of knowledge and no adoption of the courses of action and the allocation of resources for knowledge management. So currently there is no strategy for the management of knowledge. The available activities and means for knowledge management are currently not sufficient to contribute to adopting the courses of action for (neither a codification or personalization) knowledge management strategy.

**Current situation in other project-based organizations in the construction industry**
Five organizations in the construction industry were interviewed on their view on knowledge management. How they deal with knowledge and knowledge management is however different per organization. The maturity of these organization ranges from the initial level to knowledge manager level. Some organizations implement clear strategies, other have not yet established a course of action for knowledge management.

**Requirements for a knowledge management strategy for Boskalis**
The ten conditions for selecting a knowledge management strategy, as can be seen in Table 16, were determined for Boskalis:

- Boskalis are pioneers in their industry, but supply a mature product.
• Employees have a dense social network through which they can exchange information in an informal way.
• Most employees are motivated by an improved organization and personal development.
• The attitude of Boskalis employees can be characterized as easy going.
• The organization can be characterized local but has an ambition to become more professional.
• The community is very masculine and closed; employees will first try to solve problems themselves before asking for help.
• Most employees prefer sharing tacit knowledge.
• Many tasks are frequently repeated and
• A majority of the employees would often visit, contribute to and help to maintain a database.

These conditions were used to distil requirements for a knowledge management strategy for Boskalis:
 1. Innovation: determine which subjects are innovative and which are mature.
 2. Network: enlarge the dense social network.
 3. Motivation: Development of individuals and teams and involving your employees in the successes of the organization.
 4. Attitude: Informal, easy going atmosphere at knowledge gatherings.
 5. Organization: Familiar, safe atmosphere and involve other departments and projects in the knowledge management scope.
 6. Community: Help new employees to find the required knowledge and to learn.
 7. Sharing: Transfer of experience of resigning employees.
 8. Frequency of repeating tasks: Determine which tasks are frequently and which are infrequently repeated
 9. Willingness to follow processes: Determine which wheel are reinvented

Most effective KM strategy for Boskalis
Overall, it would be most effective for Boskalis to deploy a personalization strategy which focuses on the flow of tacit knowledge through personal contacts. They dense social network, informal, easy going, familiar and safe atmosphere and the preference for sharing implicit, personal knowledge can be utilized in a personalization strategy. Because of a low willingness to follow processes and a low cost-efficiency for databases in the organization, implement a codification strategy little effective for Boskalis. For the condition on innovation neither a personalization strategy or a codification strategy would be most effective. For the frequently repeated tasks and the closed community in the organization, a codification approach is would be more effective.

Implementation of a personalization strategy at Boskalis
A set of short-term, mid-term, long-term and very long-term solutions have been designed in order to achieve the main advice for Boskalis: To implement a personalization strategy towards knowledge management. The short-term solutions are solutions which can be achieved in three months time. These solutions are based on improving existing activities within the organization. Mid-term solutions will take about a year to implement in the organization. These solutions focus on identifying where knowledge is contained within the organization and making this organization wide knowledge available for the department Bebo. The long-term solutions take about two years to implement and deal with establishing knowledge management in processes. The very long-term solutions, after successfully implementing the previous solutions, are reviewing the conditions for choosing a knowledge management strategy.

In the responsibility for implementing a knowledge management strategy, three important groups can be identified. The employees who are responsible for participating in and give input to the knowledge management activities. The management, who is responsible for supporting and making resources available
for the activities and a ‘knowledge manager’ who is responsible for facilitating knowledge management activities within the organization.

The success of implementation of a knowledge management strategy fall or stands with the long-term dedication to knowledge management, setting objectives for adopting a personalization course of action and the allocation of resources necessary for carrying out these objectives. Management is responsible for implementing these solutions and therefore their support and dedication are crucial to making a personalization strategy for knowledge management a success within Boskalis.

This success for Boskalis, or intended results after implementing a personalization strategy as was advised, relate to helping the department Bebo to ensure continuity of operations through achieving an increased knowledge transfer, a higher average on MEAT scores and more effective communication and collaboration.

**Aspects of implementing such a strategy which are of value to the industry**

The organizations in the construction industry which are already implementing a clear knowledge management strategy will have little benefit from this research except for a check-up verify their course of action. Other organizations can use the ten conditions to determine which strategy would be the best course of action to take for their organization. One interviewed organization gave answers similar to those given by interviewees from Boskalis. This organization can take a look at the proposed solutions for Boskalis because many aspects will also apply to this organization.

## 8.2 REFLECTION

### 8.2.1 REFLECTION ON THE RESEARCH

**Implication of the research**

Most scientific research on knowledge management focused on codification of explicit knowledge and less on the transfer of tacit knowledge. Also there was no sufficient approach on how a company should determine which strategy is suitable for their organization. The indication of ten conditions for selecting a knowledge management strategy from literature on the people, process and technology aspects of knowledge management provides a theoretical approach for organizations to select a suitable knowledge management strategy and extends the available literature.

**Scope of the research**

The scope of this research proved challenging as well as interesting from a scientific point of view. The conditions for selecting a knowledge management strategy were applied to the construction industry and more specific to Boskalis Bebo. The construction industry and Boskalis are an interesting case study for applying knowledge management, compared to cases presented in literature. In chapter 2, some characteristics of the construction industry were presented. One of those characteristics is that the construction industry has a laggard reaction to adopting non-technical innovation. Cases presented in literature mostly include industries or organizations which are heralds in such innovation. This makes these cases interesting from a scientific point of view, but this laggard reaction makes doing research in such environment more challenging.

From a practical point of view limiting research to knowledge, knowledge management and knowledge management strategies will help organizations in the tender phase of the construction industry deal with some of the changes occurring in the construction industry, but not with all. As was explained in chapter 4, Only the internal factors in a competitive bidding process can be influenced by the organization itself. Adopting a knowledge management strategy was said to help the organization increase its average MEAT scores, effective
communication, knowledge transfer and collaboration. These are only a small number of objectives set by the Boskalis Bebo to ensure continuity of its operation. To ensure more continuity of operations and adaptation to changes in the industry in order to, to improve their chances of making more profit; more research needs to be done into the internal factors in a competitive bidding process in the construction industry.

**Literature study**
Theoretical research has been done to determine what knowledge, knowledge management and knowledge management strategies are. Ten conditions for selecting a knowledge management have been derived from literature on the people, processes and technology components of knowledge management.

Between these ten conditions no distinction has been made between the contributions of these conditions to selecting a strategy. More theoretical research should be done to determine the contribution of each condition for selecting a knowledge management strategy.

**Methodology**
The research framework, as presented in Chapter 3 proved to be helpful in managing the research process. Some difficulties were encountered during the problem definition phase of the research. This was due to challenging environment for scoping the research and lacking experience of the researcher (which will be reflected on in the personal reflection). The framework provided support under these conditions. Verification and validation from literature and the field helped to scope the research and define the research problem. Further validation and verification helped to ensure whether that the correct solutions have been correctly designed for Boskalis.

**Field study**
During the field study, a number of interviews were held; exploratory interviews, external and internal interviews. A total of 27 interviews were held, limiting the research by the number of interviewees. Especially during the external interviewees only one employee per organization was interviewed. To be able to do give better recommendations for the industry, more organizations and more employees need to be interviewed to gain a better empirical basis for this research.

Furthermore these interviews have been limited to organizations in the construction industry. In order to gain an empirical basis for widely implementable conditions for selecting a knowledge management strategy, organizations in other project phases and even industries need to be involved in the research. Also more empirical research needs to be done to determine the contribution of each condition for selecting a knowledge management strategy in different industries.

**Design phase**
The design phase was focused on the case Boskalis. During this phase Boskalis specific requirements were distilled from interviewees’ answers to the ten conditions for selecting a knowledge management strategy. From which, on its turn, a design or advice for Boskalis followed. The conditions only help to select a strategy and provide little framework to come up with general requirements. Therefore more research should be done into a general and structured method for determining requirements and solutions from the different conditions.

The conditions might provide little framework for a general method for determining requirements and solutions, the conditions have been validated and verified which did lead to a Boskalis specific design. So have the solutions been verified to satisfy the Boskalis specific requirements (in the design loop). In this verification is not taken along how well the solutions fit the requirements. To do so, the requirements should be made functional and measurable. Too little time was available during this research to gain insights into the functionality of those requirements.
8.2.2 RECOMMENDATIONS

The reflection of the different research phases leads to a number of recommendations for future research:

- Recommendations for future research within Boskalis:
  o Do more research into the internal factors for competitive bidding and use this as a support to determine a corporate strategy to ensure continuity of operations and to improve their chances of making more profit.
  o Gain insights in the functionality of the requirements and do a re-verification of the design.

- Recommendations for future scientific research:
  o More theoretical and empirical research should be done to determine the contribution of each condition for selecting a knowledge management strategy.
  o This research should be broadened to different organizations and industries, and attention should be paid to a representative sample of interviewees.
  o Finally more research should be done into general and structured method for determining requirements and solutions from the different conditions.

8.2.3 PERSONAL REFLECTION

Conducting a research is a difficult task. The researcher has learned a lot during this research period and would approach things differently using the experience gained during this research. To start with the problem definition. Having a background in civil engineering and construction management and engineering, during these studies emphasis was put on solving a more or less defined problem; Rather than defining the problem. These difficulties in problem definition made it difficult to scope the research and to gather the right data for the unclearly defined research scope. Doing this research for an organization which has a similar attitude towards solving problems did not make it easier to define the research problem and scope.

What also contributed to the difficulties in defining the research scope was the researchers’ unfamiliarity with the research topic: knowledge management. It is very interesting and motivating to learn about such a new subject and the researcher is glad to have gained new insights in knowledge as asset to the organization.

Furthermore writing a report on knowledge management is difficult when you are used to using numbers in reports and being corrected on spelling. During the research the researcher has learned a lot about the structure and continuity of text, and still has a lot more to learn!
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