



# THE POTENTIAL OF KNOWLEDGE MANAGEMENT ON CONSTRUCTION SITES

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Knowledge management is the process of creating, sharing, using, and managing knowledge, one of the most valuable organizational resources. This approach is well-known in Austria's industrial sector, but applied only in major construction companies. It is mainly used to share knowledge between different departments, but it is not commonly found on construction sites. During the construction phase a variety of separate firms build a temporary multidisciplinary organization, to produce investment goods. To show the potential of knowledge management on building sites in Austria, 78 interviews were conducted. Construction sites of different types (new construction and refurbishment of buildings) were taken into account in order to guarantee a representative outcome. The highest cost-benefit ratio for knowledge management can be seen in knowledge intensive processes. The execution phase is characterized by craftwork which often includes many routine steps. But the survey shows that almost a quarter of the daily business is about knowledge intensive processes while the amount doesn't correlate with the working experience. Furthermore, on construction sites with many trades the lack of information and knowledge transfer is the cause of nearly a quarter of the problems faced. The findings indicate the need for knowledge management on construction sites and the potential grows with the number of trades. The teambuilding process can be seen as the most important step for an efficient knowledge management during the execution phase.

*Keywords:* Knowledge transfer, Tacit knowledge, Explicit knowledge, Communication, Construction phase, Connectivity, Teambuilding, Austria.

## 1 INTRODUCTION

Knowledge Management is a strategy for getting the right knowledge to the right person at the right time and helping them to share it and put information into action to improve organizational performance (O'Dell and Grayson 1998). Additional knowledge is the theoretical and practical skill a person owns and uses to solve problems. It is based on data and information, but in contrast it is linked to a person (Probst *et al.* 2006).

The origins of this go back to the year 400 BC when the philosophers Plato and Aristotle discussed the acquisition, the forms and transfer of knowledge (Ritter *et al.* 2007). Michael Polanyi (1966) was the first to divide knowledge into implicit and tacit, one of the most important basics for further research in this field. Explicit knowledge can be measured, captured, examined and codified into documents. In contrast tacit knowledge is very hard to transfer because it relies on a person's experiences (Polanyi 1966, Pathirage *et al.* 2008). The scientific peak of

knowledge management was in the late 20th to the first decade of the 21st century and resulted from the publication of the 'Knowledge Creating Company' (Nonaka and Takeuchi 1995) in which the knowledge spiral was presented, which is the fundament for many of the following knowledge models. The knowledge management approach is well-known in Austria's industrial sector, but applied only in major construction companies even though it can improve every phase of a construction project from the acquisition to the handover and operation (Wais 2006). It is mainly used to share knowledge between different departments, but it is not commonly found on construction sites (Rathswohl 2014). An obstacle for the implementation of knowledge management in the construction industry is the lack of pragmatic and simple measures and tools (Cüppers 2006).

During the project execution phase, the various trades working on site form a temporary organization (Grover and Froese 2016). The problem in this specific phase is that these different working parties do not have any contractual relationships and are not familiar with each other and as a result they do not share any knowledge. The thoughts about knowledge management often lead to traditional information and communication technologies (e.g. data bases), but beneath the technical surface the human element (willingness for knowledge sharing) and organizational aspect (conditions for knowledge management provided by the company) are also pillars essential for success (Bullinger *et al.* 1997). The affects for knowledge sharing in project based organizations are trust, organizational culture (how people behave), organizational structure (coordination and supervision within the organization), IT infrastructure, top management support, communication and furthermore willingness to share knowledge (Ju *et al.* 2017).

A survey in Germany showed that knowledge transfer in the construction industry is inhibited through temporal, spatial, contextual and social barriers. It indicated that Mobile devices like smartphones or tablets could increase the connectivity and thus also knowledge transfer (Waizenegger *et al.* 2016). According to a survey conducted in the construction industry in Turkey the common driver for knowledge management is reducing rework effort (Kivrak *et al.* 2008), while a study in the United Kingdom points to the sharing of tacit knowledge as one of the most important drivers (Carrillo *et al.* 2004). Subsequent to reporting on all of these findings the study determines the knowledge management behavior on construction sites in Austria during the execution phase. The preconditions for multidisciplinary knowledge exchange as well as the potential of knowledge management are identified.

## 2 METHOD

In order to identify the potential of knowledge management at the trade layer on Austria's construction sites a situation analysis through semi-structured interviews were conducted to ensure the maintenance of consistency over the concepts covered in each interview (Corbin and Strauss 2015). Six constructions sites of different types in the Province of Styria were taken into account for the investigation. These were: (1) a new residential construction project with more than 150 units, (2) the demolition and new construction of a three storied apartment building, (3) the refurbishment of a brewery, (4) the renovation of a residential project with five units, (5) the new construction of a detached house and (6) the renovation of a detached house. (1) This project was located in Graz, the provincial capital of Styria, while the others were located in Murau, a town in Upper Styria. 78 semi-structured interviews were conducted with experts which were selected following a study of the site documents. The chosen interviewees had to work on the site in a trade which had at least one intersection with another company during the execution phase. The 78 participants aged between 23 and 72 represented 29 different professional groups of the 6 investigated construction sites to guarantee a holistic output. With the age mix chosen it was aimed to identify correlations with the ages or work experience and the answers. The

professional groups considered are distributed as follows: (1) 16 carcass workers, (2) 42 interior construction workers, (3) 19 workers for building services and (4) one worker for the demolition process. The aim was to include at least one person of every trade to record all interfaces and interactions. The semi-structured interviews were carried out by two researchers face to face or by telephone and were audio recorded. The audio recordings were subsequently transcribed, cleaned, coded and analyzed through a qualitative content analysis. The interview guideline was divided into four research parts: (1) knowledge intensive processes, (2) problems during the execution phase, (3) multidisciplinary knowledge exchange and (4) digital tools. To achieve a profitable knowledge management with a justified cost-benefit ratio, the implementation should concentrate on (1) knowledge intensive processes. In contrast to routine processes they create, transfer and use knowledge within the work steps. Knowledge intensive processes are characterized by high complexity, few repetitions, a high degree of novelty and little available data. With the section (2) problems during the execution phase, it was aimed to identify if any problems are caused by the lack of information and knowledge transfer. In the third category (3) multidisciplinary knowledge exchange it was clarified if the different trades could learn something from each. Regarding to Bullinger *et al.* (1997) a holistic knowledge management consists of IT-Infrastructure, supportive organization and keen humans. The last part (4) should evaluate the current usage of digital tools and the potential of further IT.

### 3 RESULTS

#### 3.1 Knowledge Intensive Processes

In this part the interviewees should estimate their daily work in the categories routine processes or knowledge intensive processes. Figure 1 shows the distribution over all investigated sites categorized by the professional experience of the interviewee.

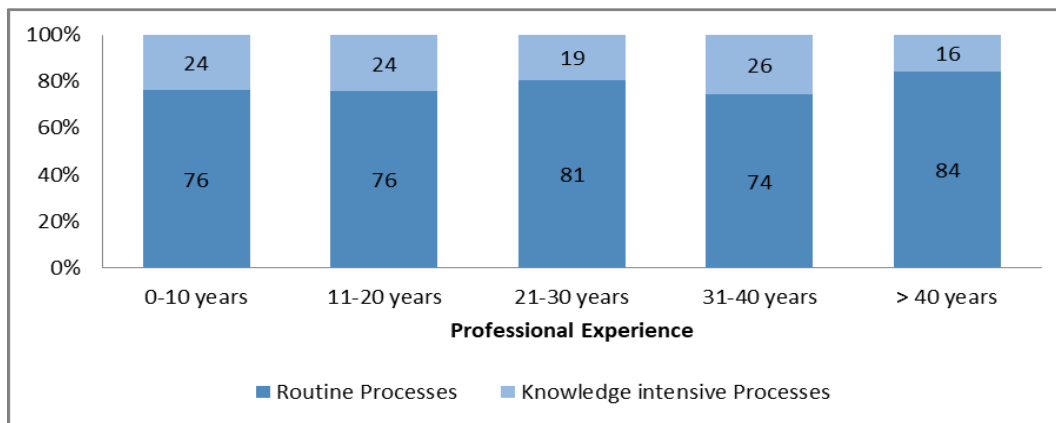


Figure 1. Distribution of knowledge intensive processes in dependence on age.

According to the interviewees on average 78% of the daily business on a building site are routine while 22% are knowledge intensive processes. The knowledge intensive processes are result from: (1) 41% first use of materials, technologies or building methods, (2) 32% detailed solutions, (3) 11% construction process, (4) 10% project type, (5) 4% technical standards and law and (6) 2% project organization.

### 3.2 Problems During the Execution Phase

This section identified the main triggers for problems during the execution phase. 72% interviewees of the construction sites (2), (3), (4), (5) and (6) (see chapter 2 Method) told us they had not noticed any disturbances, while no one involved in project (1) indicated this in their answers. On average in all the investigated construction sites 38% of the problems were bound to construction disturbances (e.g. weather) while 30% were caused by planning problems. Both are very common problem issues for the construction industry. The remaining problems could be divided into 17% caused by the client and 15% due to the lack of communication and knowledge transfer.

### 3.3 Multidisciplinary Knowledge Exchange

In order to evaluate the potential of multidisciplinary knowledge exchange in the construction industry participants were asked if the different trades could learn something from each other and what would force them to exchange their knowledge with other companies. 90% of the interviewees believed the trades definitely could learn from each other and would benefit from this exchange. The other 10% are divided in 5% who tend to agree and 5% who see no benefit in knowledge sharing.

The following preconditions for knowledge exchange were reported: (1) 64% personal contact, (2) 20% interest, (3) 9% trust and (4) 7% same language.

### 3.4 Digital Tools

People were asked about their willingness to use digital tools to support the knowledge and information exchange on the construction site. Figure 2 shows the distribution of the answers.

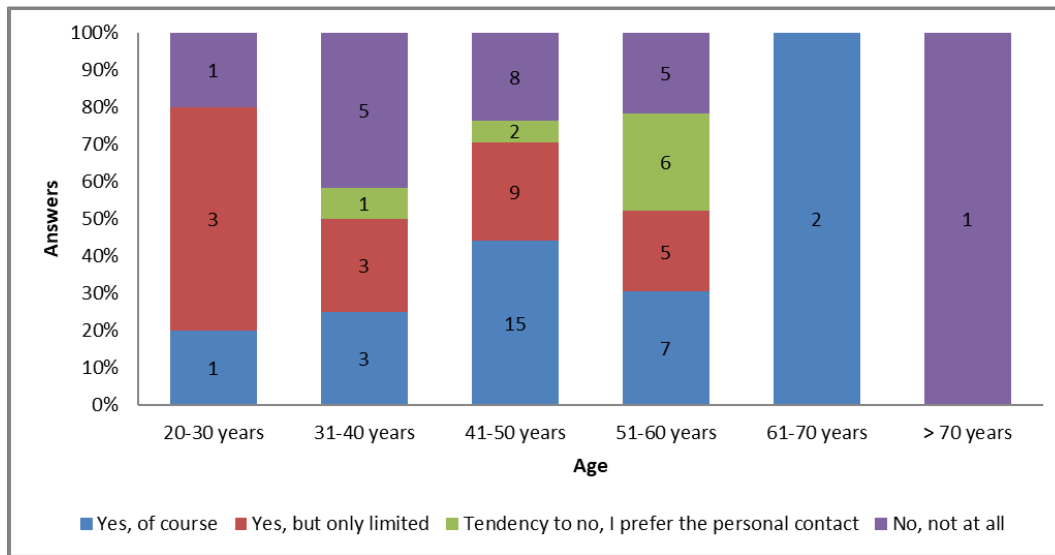


Figure 2. Willingness to use digital tools.

On average across all age groups the answers were distributed as follows: (1) 36% Yes, of course, (2) 26% Yes, but only limited, (3) 12% Tendency to no, I prefer the personal contact, (4) 26% No, not at all.

## 4 DISCUSSION

Even if the building industry is characterized by routine processes, as a result of the study it was established that almost a quarter of the processes are knowledge intensive, which indicates potential for knowledge management. It can be seen that there is no significant correlation between the age and the amount of knowledge intensive processes. The reason is because the building industry is faced with new materials, technologies, building methods and detailed solutions on a daily basis. An apprentice will naturally face knowledge intensive processes virtually each working day, because every method or material is something new. The challenge – for the new and experienced worker - is to react swiftly and efficiently on this unforeseen situation. Knowledge management can support the knowledge finding processes, which makes the execution phase more efficient. According to the survey the major portion of all problems on the investigated sites were related to the planning process and construction disturbances (e.g. weather), which are very common issues for the construction industry. A surprise result of the detailed analysis, however, was that the answer “communication and knowledge transfer” was only given on construction site (1) where it caused almost a quarter of the problems. An explanation could be the bigger project size and the location in a larger city. In fact, the interviewees mentioned that the communication on construction sites in non-urban areas is always easier because the people know each other from other projects. This conforms with the outcome of the section on multidisciplinary knowledge exchange. Future research is necessary to identify the differences of communication and knowledge sharing in urban and non-urban sites. It can be seen as very positive that the majority of the interviewees think the different trades could both learn something from each other and would benefit from doing so. The preconditions “personal contact” and “trust” referred to indicate that the laborers today do their daily tasks without having any contact to the people working next to them and furthermore they neither want to communicate nor to share information and knowledge. Knowledge management thus has the potential to reduce problems during the execution phase by linking the people at work. But it also indicates that not every building site is faced with problems caused by the lack of communication and knowledge transfer. The biggest effort can be seen on complex construction sites involving trades, which have never worked together previously, a situation that arises frequently in the bigger cities. Kivrak et al. (2008) indicated reducing rework as a common driver for knowledge management, while 20% of the interviewees mentioned “interest” as their precondition. This category means that the worker will only be willing to share knowledge when seeing own advantages from doing so (e.g. saving time). An efficient knowledge management is based on a supportive organizational structure, open-minded corporate culture and an appropriate IT-infrastructure (Bullinger *et al.* 1997). Use of a digital tool is an essential for connecting the different companies at work on the site. The majority (Fig. 2) are willing to use IT to support the knowledge exchange. A detailed look at the answer “Yes, of course” shows that the majority of those who gave this answer are over 41 years old. In this the prejudice that older people are not willing to use digital tools cannot be validated. This conclusion is also borne out by the finding that the younger generation is more skeptical and frequently does not believe that digital tools can be the miracle cure for every problem. The IT-Infrastructure could bring a solution for the language problem mentioned in chapter 3.3 by the inclusion of a translation function.

## 5 CONCLUSIONS

The qualitative interviews resulted potential for knowledge management on the construction site. But it also can be seen that not every building project needs this approach. The number of problems, especially the ones related to communication and knowledge transfer, increase

with the size and complexity of a construction project. This indicates that large projects stand to gain more from knowledge management than small ones (e.g. detached houses). Contrary to expectations the working experience does not correlate with the number of knowledge intensive processes. The lack of well-structured multidisciplinary organization and open minded workers can be seen as the most important barrier for knowledge management on the construction site as well as its highest potential. Linking the people working on the trade layer will help reduce problems as a result of heightened communication and knowledge sharing. The opinions of interviewees on the subject of digital tools confirms this finding. They would use a digital tool to support the knowledge sharing, but the organizational boundary conditions must be set in advance. The different trades create a temporary organization during the execution phase but they are not building a team. Further research is necessary to identify processes in order to break down the barriers described above and to push through and establish a satisfactory multidisciplinary knowledge management.

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