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Automotive Supply-Chain Requirements for a Time-Critical Knowledge Management

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Transforming increasingly growing data volumes into knowledge and improving its usage requires knowledge management models (KMM). KMM structures the workflow for decision taking based on knowledge. Industry-suitable requirements for a KMM, in particular for automotive supply chains (SC) and supply-critical bottlenecks, are not raised, especially concerning the crucial parameter of time-criticality. As none of the investigated models suits time-related specifications, requirements for time-critical knowledge management (KM) are derived from former case studies (CS) in the manufacturing automotive industry by literature research. These requirements will be used to evaluate existing KMM proposed in literature. Requirements for a KMM, which supports the manufacturing automotive industry (AI) in time-critical cases, are collected from practice by means of group discussions, generalised, abstracted and verified such as real-time capability, availability and accessibility, incentives for knowledge-sharing or intuitive handling. In particular, it addresses the application case of a supply-critical bottleneck in the inbound logistics. This results in rethinking of knowledge as a fundamental, time-critical resource for the reduction of supply risks. Currently, there are neither KMMs that involve time-criticality supporting industry to deal with increasing data and knowledge volumes nor precise requirements for time-critical KM in case of a supply-bottleneck in the AI. The importance of time-critical knowledge in contrast to mere data is shown. Finally, time-criticality is highlighted by showing its value to minimise production-breakdown-risks. The aim is to raise awareness about the need for changes in existing processes in the AI and to define the scope of scientific research needs.

Keywords: time-critical knowledge management; bottleneck management; automotive industry requirements; case study research

1 Introduction

Knowledge and fundamental data have, as a key success factor to the creation of competitive advantages, placed their importance as significant and precious resources in the management ideas of the AI. Fashionable concepts such as Big Data and Industry4.0 are an integral part of the company environment. Data is collected and stored which makes the data volume grow exponentially. This poses new challenges for the AI, as the collected data has to be useable and applied to generate and to disseminate knowledge. It is becoming increasingly clear that the collection and storage of large amounts of data only helps if it is not understood as a self-purpose, but the use of this data is paramount.

What is the role of time? Time as a success factor for the competitive advantages of producing companies in the AI is fundamental: the production times of individual products, as well as the delivery times of suppliers and to customers must always be reduced. Innovations must be brought rapidly to market; the products are subject to constant change. The consumer adapts to these shortened cycles and expects a constant stream of innovations. True to the motto of Rudolf von Bennigsen-Foerderer (1923-89) ”Standstill is a step back” (Buchenau, 2016, p.191), the industries do their utmost to promote change. The bulk of the information used in the AI is not static, but rather time-critical, flexible and changeable. A KMM, which takes knowledge as static, fixed quantities, may not meet the requirements of the industry and, rather than help, delay, unsettle and thus create risks for the supply of the production.

The use of collected data results in the necessity of integrating time-criticality into KMMs. In the course of this, the requirements for such a time-critical KMM have to be determined and presented in the manufacturing AI. These requirements thus form the basis of a KMM which is adapted to current needs of the AI for the optimal use of collected data in the form of knowledge.

The target of this paper is to define precise requirements for a KMM from the AI that are not yet fulfilled by existing KMM. Their suitability for the industrial environment of the AI, especially in time-critical fields, is the focus of the investigation. The central aspect is the application of a supply-critical bottleneck. The structure of the work provides for an examination of the theoretical and practical problem background in chapter 2, followed by a description of the methodological procedure in chapter 3. Empirical analyses in the form of the inclusion of investigative CSs, whose findings are cumulatively evaluated, are used to meet requirements with the objective of providing comprehensive knowledge of time-critical information. Chapter 4 deals with the implementation and the findings, followed by the evaluation (chapter 5). The special requirements of the subjects are abstracted and generalised. The work concludes with a summary in chapter 6.

2 Theoretical Perspectives on Knowledge Management

2.1 Difference between Knowledge and Data in Literature

Despite the frequently erroneously synonymous use of the terms ”data”, ”information” and ”knowledge” in everyday usage, there are serious differences in the actual meaning, which makes a delimitation of the terms necessary.

Signs form the basis. Data includes arbitrary strings and value is assigned to the character by syntax. Through collusion on specific characters and strings, the user is able to recognise the contents of data. As soon as the data is linked together and a causal link is assigned to them in form of semantics, they become information (Bodendorf, 2006, pp.1-2; North, 2011, pp.36-37). Use of information in this context already means the generation of knowledge which is understood to mean the networking of information with the objective of using and applying it purposefully. In order to connect and interpret information in the correct, meaningful and effective manner, it is often necessary to have prior knowledge that the user either already possesses or has to acquire (Bodendorf, 2006, pp.1-2; North, 2011, pp.36-37; Nikodemus, 2017, pp.83-86).This leads to the conclusion that knowledge includes not only the networking of information but also experiences and knowledge, abilities and skills, values, know-how and qualifications (Nikodemus, 2017, pp.85-86).

This distinction also is highly relevant today as it corresponds to the Industry 4.0 Maturity Index, a recent study from catech, which describes the digital transformation of companies. The acatech industry 4.0 Maturity Index serves as a guide for companies interested in advancing their degree of digitalisation and is build up as a six stepped model: ”computerisation” and ”connectivity”, which form together the group ”digitalisation”, ”visibility”, ”transparancy”, ”predictive power” and ”adaptability”, which form the category ”Industry 4.0” (Schuh et al., 2017, pp.15-18). These model levels are in line with the knowledge pyramid of Bodendorf (2006) as they represent a detailing and extension of it. ”Signs” have to be reconciled with the ”digitalisation”. This is followed by the ”data” level, which is equivalent to ”visibility”: ”What happens?” A causal link follows in the next step, the ”transparency”. A forecast for the future, which is possible only by means of knowledge, completes the model for the Industry4.0 Maturity Index.

2.2 Knowledge Management in Automotive Industrial Environment

In the AI, data is collected and used in large quantities. However, this development is often still at an early stage, so that not all potentials are fully exploited: knowledge is collected, but not processed; processed, but not linked; linked but not communicated. In a company, knowledge is often only present within certain fields and is not shared by either the system or the employees of different departments. The transition from implicit to explicit knowledge is often interrupted (cf. section 2.3.1). This makes the integration of a new KM in companies necessary.

2.2.1 Special Case: Time-Criticality

KM as a necessary concept for a modern company organisation is not a new approach (Born, 2009; Lakshman and Parente, 2008; Jane Zhao and Anand, 2009). However, one important factor is missing: the time. It plays an important role in the manufacturing industry. True to the principle of ”time is money”, time is a great influence on competitiveness, securing the market position as well as the size of the output and productivity. A KM concept for the industry has to consider and integrate this factor. The time-criticality includes on the one hand time-critical processes and a time-critical information provision, on the other hand also time-critical information.

2.2.2 Bottleneck-Management in the Automotive Industry

This chapter is an excerpt from practice in the form of an experience report.

In the AI a distinction is made between bottleneck-management, which aims to prevent bottlenecks on the production proactively, and the bottleneck-control, which takes place after the occurrence of a supply-critical bottleneck and deals with the regulation and distribution over affected plants (reactive).

Bottleneck-management is a particularly illustrative application for a time-critical KM. Within the scope of capacity management, the supply assurance of the production is checked at regular intervals. For this purpose, the production capacity provided by the supplier is compared with the parts requirements determined by the Original Equipment Manufacturer (OEM). Since these needs and capacities vary according to the order, to the machine utilisation, shift models and holidays, a system determines ”secured” and ”unsecured” weeks by comparison. Identified ”unsecured” weeks will be investigated in the daily hedging process, so that risks can be ruled out at an early stage.

However, the supplier often suffers short-term supply disruptions, for example due to political unrest, natural catastrophes or financial disasters. In these cases, rapid action is crucial in order not to endanger production. Manual data is collected along the SC. Contact persons are identified and get informed. An internal team consisting of procurement, logistics and partial quality assurance is compiled and contacts the supplier in regular telephone conferences. For these conferences, data is collected in advance. This proves to be difficult because of the person-dependent limitation with regard to data’s availability: information on logistics, procurement and quality assurance is only disclosed to the other involved parties in order to deal with the time-critical situation in the best possible way. The manual effort to receive the message with regard to a supplier-critical situation at the supplier up to the time the SC and the contact persons are known and all relevant data for the management of a supply-bottleneck, is enormous and can take an average of up to a week. In a time-critical supply-bottleneck, one week could be the cause for a production breakdown and profit loss. Therefore a time-critical KMM is needed, which helps to deal with acute knowledge in time-critical situations which are of paramount importance.

2.3 Knowledge Management Models

A literature review for KMM by using the keyword ”knowledge management” yields numerous hits. Adding the keyword ”time-critical” has no useful result. For this reason, a further literature review for time-critical KM is not effective. Nevertheless, this chapter will provide an overview of the core idea of KM but will not give a summary of all KMM. The models generally deal with the process of generating and disseminating knowledge. Some of these models address theoretical approaches to deal with knowledge, for example knowledge-based theory or competence-based theory (Martensson, 2000, p.205). Others do not integrate industrial but individual requirements (Reinmann-Rothmeier and Eppler, 2008). The third category identifies requirements of industry and abstracts these in the form of business driven KMM.

From the third group, three models will be presented, which are covering a wide spectrum and are the basis for many other models, just like North (2011), Gronau (2009) or Nikodemus (2017). The SECI-model from Nonaka and Takeuchi (1997) is one of the fundamental models for the understanding of KM today. Probst, Raub and Romhardt (2012) take up further industry requirements and expand the SECI-model. Their approach to anchoring KM in the industry becomes apparent. The ”Magical Triangle of KM” is presented as the third model. This model takes on other requirements of industry and attempts to abstract and generalise them (Gehle, 2006; Rücker, 2002).

2.3.1 SECI-Model by Nonaka and Takeuchi

Nonaka and Takeuchi distinguish between explicit and implicit knowledge. Explicit knowledge means written knowledge, which can be easily transmitted. In contrast, implicit knowledge is only available to the knowledge carrier, often unconsciously. It is hard or impossible to be transferred (Nonaka and Takeuchi, 1997, p.75).

According to Nonaka and Takeuchi (1997, p.75) these two types of knowledge can be transformed in the form of a continuous knowledge spiral, thus generating knowledge. Four successive phases are performed regularly:

- Transformation from implicit to implicit knowledge is called Socialisation. It means the acquisition of individual, implicit knowledge.
- Transformation from implicit to explicit knowledge is called Externalisation. It describes the documentation of implicit knowledge to become explicit.
- Transformation from explicit to explicit knowledge is called Combination and means the arrangement of the new explicit knowledge with already existing explicit knowledge.
- Transformation from explicit to implicit knowledge is called Internalisation and refers about the assimilation of new knowledge and becoming implicit knowledge.

This means that individual knowledge can be transferred to an ever-increasing organisational level within an organisation, making it accessible. Nonaka and Takeuchi (1997, p.75) have thus created a general model that helps for example in a company, to develop and multiply knowledge, and thereby to manage the generation of knowledge.

This model is therefore a basis for the understanding of the generation of knowledge, which is also applied in companies, but the time factor is not integrated. Time-critical knowledge is treated according to this model as well as time-uncritical. The model must therefore be adapted to the industry.

2.3.2 Knowledge Circulation by Probst, Raub and Romhardt

Probst, Raub and Romhardt (2012) proceed inductively from the requirements of the industry and abstract their results in a model. There are six problem categories that influence each other and, according to Probst, Raub and Romhardt (2012, pp.30-33), are the core processes of KM. The process of knowledge identification is intended to create transparency about internally and externally available knowledge, the process of knowledge acquisition addresses the question of the acquisition of new knowledge outside the organisation. Complementary to this is the process of knowledge development, which focuses on building new internally and externally knowledge. The knowledge sharing involves the transfer of knowledge to the right place, while the knowledge exploitation ensures the productive use of organisational knowledge. The knowledge preservation takes care of the protection against loss of knowledge. In addition, they introduce two further categories that are intended to anchor the importance of knowledge in the company: the knowledge objectives which define the direction of learning, as well as the knowledge validation for the measurement of learning success (Probst, Raub and Romhardt, 2012, pp.30-33).

New to this model is the focus on the requirements of the industry, which are necessary to implement the model in practice. However, the time factor is also not integrated in this model.

2.3.3 ”Magical Triangle of Knowledge Management”

The magic triangle of KM is widely discussed in the literature (Gehle, 2006, p.11; Rücker, 2002, p.32). All however address the approach of adapting KM to the needs of the industry by integrating the fields of ”employee/culture/personnel management”, ”organisation/processes” and ”information and communication technology” (Gehle, 2006, p.11; Rücker, 2002, p.32). This is intended to create an interdisciplinarity of KM, which is necessary for the establishment in practice (Probst, Raub and Romhardt, 2012, p.259).

In detail, this means that transparent business processes and decision-making structures, as well as training and incentives to increase knowledge are necessary. Appropriate technical preconditions must also be created (Rücker, 2002, p.32). Nevertheless, the time-criticality of knowledge is not mentioned in these models.

2.4 Need for Action

Data as a resource of the present time implies the construction of large data volumes and also requires KM, which helps to make the collected data usable. There are numerous models that deal with the generation of knowledge. Their suitability for the AI is limited, because they do not take the factor of time-criticality of knowledge and information into account.

The volume-adequate supply of the production with parts in a supply-bottleneck depends decisively on the handling of time-critical knowledge. The result is a time-critical KMM, which is adapted to industrial needs. As a basis for this, requirements for a time-critical KM have to be collected, compared and assessed from industry and science. In order to produce a representative image of reality, the requirements are gathered from several group discussions conducted in loops, which are based on the application of bottleneck-management. These practical requirements represent the starting point for further deepening with scientific research focus.

3 Methodological Approaches for the Development of Time-Critical Knowledge Management: Case Studies

3.1 Research Method Selection and Types of Designs

CSs from literature are compared with a newly recorded CS and requirements for a time-critical KM in the manufacturing AI are derived. The inclusion of CSs shall ensure a high degree of practical relevance and timeliness (Gehle, 2006, p.16). It is a qualitative research approach that is applied when complex, little explored fields of interest are considered with contextual relevance. It has the advantage that hypotheses can be derived from the practice which are verified and validated with the help of literature. This leads to new perspectives and results in a new insight and the development of new knowledge (Borchardt and Göthlich, 2009, p.46).

Following YIN (2014, pp.49-50), an embedded single-case study is presented. The bottleneck-management is used as a relevant context in the time-critical supply-bottleneck, and the different fields involved in the internal and external management are used as analysis objects.

3.2 Data Collection Method

CSs as a qualitative research method allow a variety of data collection methods (Riesenhuber, 2009, pp.6-7). According to Borchardt and Göthlich (2009, p.38), these can be divided into three categories: observation, questioning and content analysis, which differ in their approach.

The observation shows a rather passive, non-participating basic idea. Information is collected, not determined (Borchardt and Göthlich, 2009, p.38).

The survey is of a reactive nature as participants react to the directly respondent (Weber, 2009, p.147; Riesenhuber, 2009, p.12). Differentiation will be made in individual interviews, which may be personal, by telephone or in writing, and group interviews. Depending on the application, the construction is structured, partially structured or unstructured. The choice of the method depends on the application, the research question and the result to be achieved. Complex, poorly researched fields often require semi-structured interviews, which only slightly limit the possible answers. In contrast to this, a structuring is advantageous in a specific questioning, which leads to focused responses (Lamnek, 2002, p.173; Meuser and Nagel, 1991, pp.448-449).

A special form of the group interview is the group discussion. It is particularly concerned with the interaction of the group members (Fay, Garrod and Carletta, 2000, p.481; Vogel, 2014, p.581). The framework of the discussion is provided by a guideline, which supports to focus on the research topic. It includes the framework theme as well as a few individual aspects (Dammer and Szymkowiak, 1998, pp.94-95; Vogel, 2014, p.583). This method has a rather unstructured character, but it also allows a great gain in knowledge. The participants inspire each other with opinions, insights and new ideas. The interplay in a group on a particular research subject enables knowledge that is not possible through individual queries of prefabricated questionnaires (Müller, 2008, p.5; Vogel, 2014, p.582). This enables existing hidden problems and potentials to be uncovered, which the individual is not aware of or with which he has arranged himself. An advantage of this method is, on the one hand, the breaking open of fixed views and ideas; on the other hand the collective orientation can be worked out. The influencing of the participants can be disadvantageous, just as the hindrance of individual expressions of opinion due to adaptation mechanisms (Frey, 2007, p.3; Vogel, 2014, p.582).

The content analysis as the third category according to Borchardt and Göthlich is based on observations and interviews, and supplements them with information based on documents and data sets. It is thus a summary and explanation (Borchardt and Göthlich, 2009, p.38).

3.3 Further Requirements of the Method

The selection of the participants is crucial for the quality of the results. Rack and Christophersen (2009, p.28) point out that there may be differences in the survey results, depending on whether the participants participate voluntarily or involuntarily in the survey.

In group interviews or group discussions, the group's composition is also of interest. A distinction exists between real or artificial groups and homogeneous or heterogeneous groups. The former are more realistic in comparison to the latter and have a homogenous background, but are often also restricted in the openness of the discussions. In group discussions, the optimal group strength is between six and ten participants (Liebig and Nentwig-Gesemann, 2009, p.105; Vogel, 2014, p.581-584).

The optimal quantity of discussions depends on the theoretical saturation. As soon as a new survey or discussion does not bring any added value to the findings, this saturation is achieved and thus the optimal quantity of interviews or discussions (Vogel, 2014, p.584).

4 Case Study from Industrial Practice and Requirements in Literature

The method of the CS is chosen to create an image of reality and to deduce inductively from the requirements of practice to the theory behind it. Group discussions as survey methods should promote the creativity of respondents. In order to break down established behavioral patterns and perspectives in the first step, which can only be identified by the interaction in the group, this method is very suitable.

4.1 Object of the Survey

The object of the survey is a multinational large group of the AI, headquartered in Germany. A practical CS is taken as a use case. The application of a supply-critical bottleneck by the manufacturing AI provides the framework conditions for the extent of the CSs taken.

All priority fields involved in a time-critical lack of material are surveyed as shown in figure 2. Therefore, their requirements for a time-critical KMM are recorded and then compared with each other. The requirements of the participants are used to derive abstracted, generally valid requirements for time-critical KM for volume-critical supply-bottlenecks in the AI.

4.2 Process, Participants and Timeframe

The method of group discussion is applied on the basis of suitability for the present application. The target is to uncover hidden potentials in bottleneck-management, which are unaware of the individual. Further advantages in the benefit of group dynamics lie in the integration of all involved parties to increase the motivation as well as the promotion of creativity. A guide is limited to the theme of bottleneck-management and defines the calls to discuss the process, to highlight obstacles, to uncover information gaps, and to present personal requirements to an "optimal" process.

The participants are selected on the basis of the need for motivated and committed participants on a voluntary basis. All those involved in the bottleneck-management application are invited to participate in the group discussion.

Due to the assignment to specific subject areas, they are homogeneous real groups with a range of between six and ten participants. Group-wide employees in the fields of procurement and logistics are surveyed in three large companies in the AI (OEM) as well as in an international medium-sized supplier. In total, 10 discussions are held with a total of 35 participants and, in order to ensure the anonymity of the participants, the results of the evaluation are not broken down into the fields involved.

4.3 Procedure of the Group Discussions

The discussions lasted a period of five months in the first half of 2017. The initial question, which can be seen in figure 1, is set independently for each group. To answer this question, group discussions take place. It is only in this discussion that disclosure of existing potentials is possible since the group participants are partly challenging each other by their different perceptions, partly confirming each other by their same perceptions. The contents of the discussion topics as well as the results of the discussions are documented in short protocols. Subsequently, the results are clustered and submitted to the group participants again. The group itself analyses and evaluates the results. It prioritises certain topics and places the importance of others in the background, as shown in figure 1. The clusters of results are prioritised in high potential, coloured dark grey, and low potential (light grey).

4.4 Findings from the Bottleneck-Survey

The "lived" bottleneck-process is shown in figure. In most cases, the supplier provides the first information regarding a supply risk. Depending on the risk

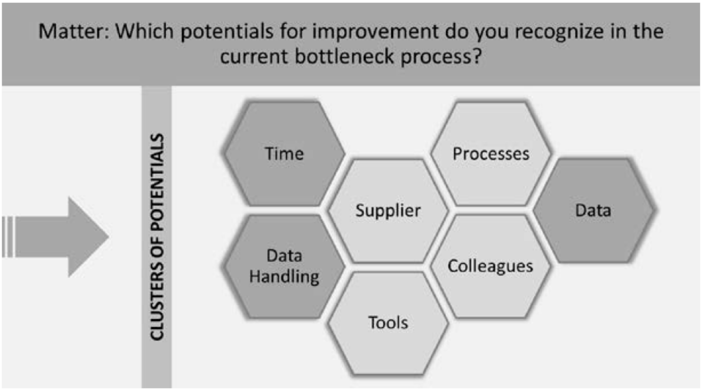

Figure 1: Clusters of potentials for the bottleneck-process in the AI

location within the SC, this information can take several days to reach the right contact person at the OEM, the responsible buyer in the normal case.

The latter then provides information on logistic and procurement, as shown in figure 2, as well as on the development of the individual brands and plants concerned. Together, they set up a team, which exchanges itself by telephone with the responsible supplier. The necessary information is determined on the basis of the system's access to the individual areas. Further information is collected manually.

A range-wide monitor correcting acute requirements with current stock allows the available parts to be allocated to the plants. If the SC is filled again and the delivery call can be operated again, the control process is passed on.

The obstacles in the current bottleneck-process are identified. The necessary manual recording of information is a great deal of time and effort for the editor. In addition, the distribution of information via e-mail by missing contact persons in the mailing list and misdirected or non-sent mail represents a major obstacle in the processing of bottlenecks. Another barrier is missing and limited access rights to information and systems. In addition, trust in the systems is limited due to faulty or obsolete data. It would be helpful to know the SC. However, these data are not available and cannot be determined due to legal restrictions in the

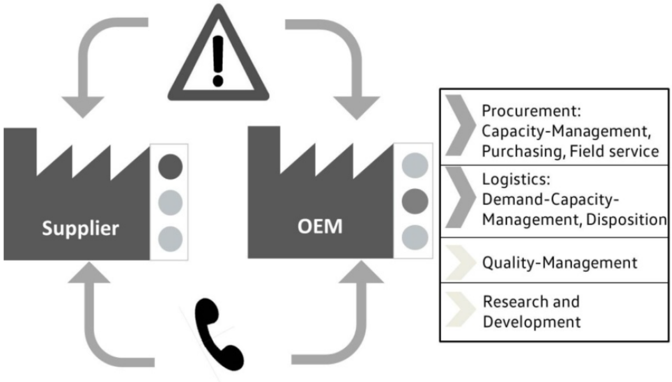

Figure 2: Bottleneck-process including the integrated departments

individual case. As a result, contacts are also lacking along the SC, which in the event of a bottleneck might have the potential to ease the situation.

5 Abstraction and Evaluation of Requirements for Time-Critical Knowledge Management

5.1 Derived, General Requirements

The described obstacles lead to requirements for bottleneck-management which can be divided into three priority categories: Requirements for data, for handlings and for time, as shown in figure 1. Requirements for the category ”time” are not broken down in detail since this paper generally deals with the requirements for time-critical KM. As a result, only two priorities remain.

5.1.1 Requirements for Data

The results of the group discussions can be summarised as follows with regard to the requirements for a time-critical KM:

Actuality of data

Time-critical knowledge requires real-time, up-to-date information. An outdated state of data can lead to incorrect decisions in specific situations, since a time-critical process requires quick decisions.

Probst, Raub and Romhardt (2012, p.217) define the actuality of data as a basis for data quality. They justify this approach, for example, with high costs for investment decisions based on outdated information (Probst, Raub and Romhardt, 2012, p.217). North (2011, p.52) also refers to the actuality of information bases. Weber and Berendt (2017, p.28) even note that a system cannot be used without a suitable data update.

Timely availability of data

In time-critical situations requiring rapid action, requested data must be immediately available. Any additional time required to find the information means that there are temporal and thus monetary losses.

North (2011, p.52) points out that time and place are the availability of knowledge-determining factors. Time differences due to global companies may not affect the availability of information.

Local availability and accessibility of data

Information must be accessible to everyone involved. In addition, it is necessary that all involved parties, regardless of their location, are informed.

According to North (2011, p.52), a local availability of data is to be taken into account especially in globally operating companies.

Quality of data

In the time-critical case, the quality of data is important, in particular, the completeness, authenticity and resilience of the information. In the case of poor information quality, optimal decisions cannot be made. Trust in the use of available data would decrease.

Probst, Raub and Romhardt (2012, p.205) declare the quality of information as crucial for databases, since databases with irrelevant data lead to mistrust and consequently to a reduced or lack of use.

5.1.2 Requirements for Handling

Trust and silo mentality

The exchange of knowledge depends to a great extent on the willingness to cooperate between the parties involved. A ”silo mentality” creates boundaries. Trust among each other and a breakup of silo thinking is therefore indispensable.

Probst, Raub and Romhardt (2012, p.127) mention the problem of the formation of inefficient knowledge bases in organisations with high communication barriers. The keys to collective knowledge creation are, according to Probst, Raub and Romhardt (2012, p.127), interaction, communication, transparency and integration.

Means of communication

A network of all participants creates the conditions for a targeted exchange of information. The means of communication must be accessible to everyone involved. They must also provide a framework appropriate to the application and generation.

According to Probst, Raub and Romhardt (2012, p.127) the success of organisations the individual knowledge of the individual can be less helpful than the knowledge between the individual, the dependencies and relationships. These relationships can only be established and maintained through interaction and communication. North (2011, p.52) puts the factor of communication in the generation of knowledge in the foreground by focusing on a personal learning of the participants.

Motivation

Incentives are needed that motivate the participants to share their knowledge and experience. This can take the form of a change in corporate culture, in which knowledge is rewarded and not the restraint of knowledge with the target of becoming irreplaceable. Another possibility consists in the approach of the Gamification of the work (Heilbrunn and Sammet, 2017, p.83).

An increased commitment by all parties involved in the implementation of common goals can be achieved through motivation (Probst, Raub and Romhardt, 2012, p.60). In the case of a lack of motivation, a transfer of knowledge is made more difficult (Probst, Raub and Romhardt, 2012, p.170).

5.2 Evaluation of Generalised Requirements

Even if the identified requirements are justified by the expert's knowledge of the group discussions, it is necessary to analyse the hurdles that the requirements have currently failed in order to allow a reduction.

The actuality of data

Data must be up-to-date and available in real-time. For this purpose, a networking of all source systems according to a suitable structure is necessary. Constant updating of certain records is required.

Timely availability of data

The information supply must be supported on the IT side in order to avoid temporal losses due to analogue information procurement.

Local availability and accessibility of data

Unrestricted access of all parties to necessary, existing data is essential. For this, a suitable tool must be available to each participant. Unrestricted communication is necessary. Access permissions for specific data headers must be extended.

Quality of data

In order to ensure high data quality, a validation of the information takes place in advance. This is possible, for example, by evaluating the reliability of the source system.

Trust and silo mentality

There has to be no holding on to old structures but openness for new solutions. An integration of all stakeholders is indispensable.

Means of communication

The means of communication must be accessible to everyone involved. They must also provide a framework appropriate to the application and generation.

Motivation

One possibility is the approach of gamification at work (Heilbrunn and Sammet, 2017, pp.85-87). It is an incentive from within. The work and especially the use of tools should be fun and therefore promote motivation. Another approach is a change in corporate culture. This is an incentive from outside, by rewarding knowledge and not by restraining knowledge with the aim of becoming irreplaceable.

5.3 Evaluation of Methods

The models of KM discussed in chapter 2.3 do not cover the requirements of industrial practice in the AI in a time-critical situation. In order to encounter this, it is necessary to deduce, outgoing from the requirements of the practice, knowledge and to transfer it into the theory. The CS is the appropriate methodology to illustrate the complexity of the practice and make it tangible. Through the inclusion of expert knowledge by group discussions, an enormous return of know-how from practice to theory is possible.

Nevertheless, it should be noted that the extent of the CS can be expanded by extending a questionnaire regarding the number of participants as well as the number and structure of questions.

A full evaluation of the added value of the methodology and the results is only possible if the identified requirements are transferred to a KMM and this model is applied in practice.

5.4 Limitations

This paper describes the basis for an adapted KMM for the structuring of knowledge. These are the items that provide a guide. The requirements are particularly applicable in the AI and cannot be fully applicable to other industries and companies. The requirements determined by surveys of a wide range of different automotive manufacturers are intended to become a general invalidity which, however, has gaps for limiting the selection.

The described case of handling time-critical knowledge in the application of the supply-critical bottleneck-management of the AI places special emphasis on the requirements in the time-critical case. These requirements may differ in the absence of time-criticality.

In addition, it will not be sufficient to rely solely on a KMM in the time-critical supply-risk. Such a model may support, but cannot replace the experience of the employees.

6 Conclusions

The present work shows that there are numerous, partly unused sources of knowledge in the AI that must be prepared and used. This is conceivable in the form of a KMM. However, literature currently lacks KMM that integrate the requirements of the time-criticality of data and processes. They are not optimally adapted to the needs of the industry.

The subdivision of the requirements (cf. figure 3) consists of two classes and depicts two fields of action: On the one hand, an optimisation of data structures is necessary in order to provide an up-to-date, complete and high-quality providing of the user's information to the users. This includes the adapted networking of data sources and the restructuring of the current network, as well as making the information accessible to all participants in the form of timely, adapted tools. On the other hand, a change in the corporate culture away from silo mentality and to the idea of a team is also a matter of cross-company activity.

However, there are further research needs. The requirements are the basis for a time-critical KMM. It is therefore necessary to analyse further models and to reconcile them with the identified needs of the industry. Hence, an adaptation of existing models is required. It should be noted that an adapted model is not sufficient for applicability in industry alone. Structuring the generated knowledge is necessary, for example in the form of an information object model.

In addition, a comprehensive analysis of the motivation factors of the users is essential, which is fundamental for the implementation and integration of a time-critical KM.

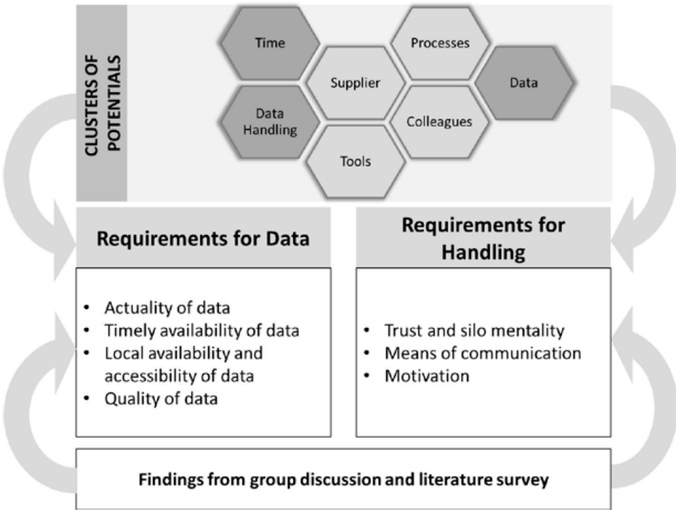

Figure 3: Conclusion of the determined requirements of the AI for time-critical KMM

References

Albers, S., D. Klapper, U. Konradt, A. Walter, and J. Wolf, eds. (2009). *Methodik der empirischen Forschung*. 3., überarbeitete und erweiterte Auflage. Wiesbaden and s.l.: Gabler Verlag.

Baur, N. and J. Blasius, eds. (2014). *Handbuch Methoden der empirischen Sozialforschung*. Wiesbaden: Springer VS.

Bodendorf, F. (2006). *Daten- und Wissensmanagement*. 2., aktualisierte und erweiterte Auflage. Springer-Lehrbuch. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg.

Borchardt, A. and S. Göthlich (2009). "Erkenntnisgewinnung durch Fallstudien". In: *Methodik der empirischen Forschung*. Ed. by S. Albers, D. Klapper, U. Konradt, A. Walter, and J. Wolf. Wiesbaden and s.l.: Gabler Verlag, pp. 33–48.

Born, V. (2009). *Problemorientiertes Wissensmanagement in der Automobilindustrie: Ein interdisziplinärer Ansatz*. Wiesbaden: Gabler Verlag / GWV Fachverlage GmbH Wiesbaden.

Buchenau, P., ed. (2016). *Chefsache Gesundheit II: Der Führungsratgeber fürs 21. Jahrhundert*. 1. Aufl. 2016. Wiesbaden: Springer Gabler.

Dammer, I. and F. Szymkowiak (1998). *Die Gruppendiskussion in der Marktforschung: Grundlagen - Moderation - Auswertung Ein Praxisleitfaden*. Wiesbaden: VS Verlag für Sozialwissenschaften.

Fay, N., S. Garrod, and J. Carletta (2000). "Group discussion as interactive dialogue or as serial monologue: the influence of group size". In: *Psychological science* 11.6, pp. 481–486.

Frey, F. (2007). *Die Gruppendiskussion als Instrument der Datenerhebung in der Marktforschung*. Grin Verlag.

Garz, D. and K. Kraimer, eds. (1991). *Qualitativ-empirische Sozialforschung: Konzepte, Methoden, Analysen*. Wiesbaden: VS Verlag für Sozialwissenschaften.

Gehle, M. (2006). *Internationales Wissensmanagement: Zur Steigerung der Flexibilität und Schlagkraft*. Deutscher Universitts Ver.

Gronau, N. (2009). *Wissen prozessorientiert managen: Methode und Werkzeuge für die Nutzung des Wettbewerbsfaktors Wissen in Unternehmen*. München: Oldenbourg.

Heilbrunn, B. and I. Sammet (2017). "G-Learning- Gamification im Kontext von betrieblichem eLearning". In: *Gamification und Serious Games*. Ed. by S. Strahringer and C. Leyh. Edition HMD, pp. 83–94.

Jane Zhao, Z. and J. Anand (2009). "A multilevel perspective on knowledge transfer: Evidence from the Chinese automotive industry". In: *Strategic Management Journal* 30.9, pp. 959–983.

König, E., ed. (2002). *Qualitative Forschung: Grundlagen und Methoden*. 2., völlig überarb. Aufl., Dr. nach Typoskript. Vol. 8218. UTB. Weinheim u.a.: Beltz.

Kühl, S., ed. (2009). *Handbuch Methoden der Organisationsforschung: Quantitative und qualitative Methoden*. 1. Aufl. Wiesbaden: Verl. für Sozialwiss. / GWV Fachverl.

Lakshman, C. and R. C. Parente (2008). "Supplier-Focused Knowledge Management in the Automobile Industry and Its Implications for Product Performance". In: *Journal of Management Studies* 42.2, pp. 317–342.

Lamnek, S. (2002). "Qualitative Interviews". In: *Qualitative Forschung*. Ed. by E. König. Vol. 8218. UTB. Weinheim u.a.: Beltz, pp. 157–193.

Liebig, B. and I. Nentwig-Gesemann (2009). "Gruppendiskussion". In: *Handbuch Methoden der Organisationsforschung*. Ed. by S. Kühl. Wiesbaden: Verl. für Sozialwiss. / GWV Fachverl., pp. 102–123.

Mårtensson, M. (2000). “A critical review of knowledge management as a management tool”. In: *Journal of Knowledge Management* 4.3, pp. 204–216.

Meuser, M. and U. Nagel (1991). “ExpertInneninterviews: vielfach erprobt, wenig bedacht : ein Beitrag zur qualitativen Methodendiskussion”. In: *Qualitativ-empirische Sozialforschung*. Ed. by D. Garz and K. Kraimer. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 441–471.

Müller, F. (2008). *Die Gruppendiskussion als Instrument der qualitativen Marktforschung und derenAnwendung im Rahmen einer vergleichenden Analys zwischen physischem und digitalem Musikgeschäft*. Grin Verlag.

Nikodemus, P. (2017). *Lernprozessorientiertes Wissensmanagement und kooperatives Lernen: Konfiguration und Koordination der Prozesse*. AKAD University Edition.

Nonaka, I. and H. Takeuchi (1997). *Die Organisation des Wissens: Wie japanische Unternehmen eine brachliegende Ressource nutzbar machen*. Frankfurt Main u.a.: Campus-Verl.

North, K. (2011). *Wissensorientierte Unternehmensführung: Wertschöpfung durch Wissen*. 5., aktualisierte und erw. Aufl. Lehrbuch. Wiesbaden: Gabler.

Probst, G., S. Raub, and K. Romhardt (2012). *Wissen managen: Wie Unternehmen ihre wertvollste Ressource optimal nutzen*. 7., überarb. und erw. Aufl. Wiesbaden: Springer Gabler.

Rack, O. and T. Christophersen (2009). “Experimente”. In: *Methodik der empirischen Forschung*. Ed. by S. Albers, D. Klapper, U. Konradt, A. Walter, and J. Wolf. Wiesbaden and s.l.: Gabler Verlag, pp. 17–32.

Radermacher, F. J., ed. (2002). *Wissensmanagement: Überlebensfrage für Großunternehmen und mittelständische Wirtschaft - das magische Dreieck: Humanressourcen, Organisation und IT-Basis: Ergebnisband Ulmer Forum 2001*. Vol. 19. Wissensverarbeitung und Gesellschaft. Ulm: Universitätsverlag Ulm.

Reinmann-Rothmeier, G. and M. J. Eppler (2008). *Wissenswege: Methoden für das persönliche Wissensmanagement*. 1. Aufl. Psychologie Praxis : Lernen mit neuen Medien. Bern: Hans Huber.

Riesenhuber, F. (2009). “Großzahlige empirische Forschung”. In: *Methodik der empirischen Forschung*. Ed. by S. Albers, D. Klapper, U. Konradt, A. Walter, and J. Wolf. Wiesbaden and s.l.: Gabler Verlag, pp. 1–16.

Rücker, B. (2002). “Überlebensfrage für Großunternehmen und mittelständische Wirtschaft: das neue magische Dreieck, Human Resources, Organisation und IT-Basis”. In: *Wissensmanagement: Überlebensfrage für Großunternehmen und mittelständische Wirtschaft - das magische Dreieck: Humanressourcen, Organisation und IT-Basis*. Ed. by F. J. Radermacher. Vol. 19. Wissensverarbeitung und Gesellschaft. Ulm: Universitätsverlag Ulm, pp. 29–45.

Schuh, G., R. Anderl, J. Gausemeier, M. ten Hompel, and W. Wahlster, eds. (2017). *Industrie 4.0 Maturity Index: Die digitale Transformation von Unternehmen gestalten*. acatech STUDIE. München: Herbert Utz Verlag.

Strahringer, S. and C. Leyh, eds. (2017). *Gamification und Serious Games: Grundlagen, Vorgehen und Anwendungen*. Edition HMD.

Vogel, S. (2014). “Gruppendiskussion”. In: *Handbuch Methoden der empirischen Sozialforschung*. Ed. by N. Baur and J. Blasius. Wiesbaden: Springer VS, pp. 581–586.

Weber, F. and J. Berendt (2017). *Robuste Unternehmen: Krisenfest in Zeiten des Umbruchs*. essentials. Wiesbaden and s.l.: Springer Fachmedien Wiesbaden.

Weber, S. M. (2009). “Großgruppenverfahren als Methoden transformativer Organisationsforschung”. In: *Handbuch Methoden der Organisationsforschung*. Ed. by S. Kühl. Wiesbaden: Verl. für Sozialwiss. / GWV Fachverl., pp. 145–179.

Yin, R. K. (2014). *Case study research: Design and methods*. 5. ed. Los Angeles CA u.a.: SAGE Publ.