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Knowledge Management within a global automotive company

Factors affecting Knowledge Dissemination from quality improvement projects

Master of Science Thesis in Quality and Operations Management

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Abstract

Knowledge as a corporate asset has been highlighted in research during the last decades. For Volvo Group Trucks, a Knowledge Management initiative has currently been rolled out in order to improve the reuse of knowledge from previous projects and enhance the product quality. A central part of Knowledge Management is Knowledge Dissemination, i.e. knowledge sharing or knowledge transfer. The Knowledge Dissemination is affected by different factors with different influence on the Knowledge Dissemination success depending on the context. The purpose of this study is to analyze Knowledge Dissemination from product quality improvement projects in a global automotive company with the intent to identify influencing factors on an intra-organizational level. The case company is Volvo Group Trucks.

This case study had a qualitative approach where interviews, mainly with concerned key individuals in product quality improvement projects, were conducted. Three types of projects were studied and a total of 23 semi-structured personal interviews were performed. A literature review has also been carried out to aid the analysis. In order to sort and structure identified factors, a research framework for analyzing Knowledge Dissemination has been used. The framework address the knowledge actors, both source and recipient, the context in which the dissemination takes place, the media used to disseminate the knowledge content, and the activity of the actors two-way interaction.

The study concluded that the most relevant recipient for knowledge from product quality improvement projects was the R&D organization and that this Knowledge Dissemination can be analyzed in a short-term and long-term perspective. The short-term perspective represents the immediate dissemination of knowledge after identifying the problem root cause and taking the decision to implement a solution. The long-term perspective reflects Knowledge Dissemination issues with taking preventive actions to avoid reoccurrence in the future. In the short-term perspective, Knowledge Dissemination is mainly dominated by means of meetings and personal interaction. Individuals from the recipient organization taking part in the projects enables Knowledge Dissemination to their specific departments and so does the trust between the actors. However, the main problems are factors related to responsibilities, feedback, resources and how the project process supports prevention of reoccurring quality issues. In the long-term perspective a database for storing knowledge at R&D is central for the Knowledge Dissemination. Main inhibitors for Knowledge Dissemination in the long-term perspective are factors related to the usage of the database and how to reuse stored knowledge, as well as management support and resources available for using the database.

In order to enhance short-term Knowledge Dissemination, and ensure its success, the recommendations concerns emphasis on a balanced product quality improvement project process, through implementation of KPIs together with a standardized evaluation of entire projects together with a clearly communicated process end and clear responsibilities for knowledge activities. In the long-term perspective, the knowledge database must be given management support and resources for reuse of knowledge. Also, it cannot be ambiguous how knowledge regarding quality issues is stored and reused, therefore measurements and education for using it is recommended.

Keywords: Knowledge Management, Knowledge Dissemination, knowledge transfer, knowledge sharing, automotive industry, quality improvement projects, influencing factors

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List of abbreviations

DVG	Design Verification Guideline
GCR	Global Component Responsible
GTO	Volvo Group Trucks Operations
GTT	Volvo Group Trucks Technology
KD	Knowledge Dissemination
KM	Knowledge Management
KPI	Key Performance Indicator
PMQJ	Project Manager Quality Journal
PQL	Project Quality Leader
QCS	Quality and Customer Satisfaction
QJ	Quality Journal
QJWB	Quality Journal White Book
R&D	Research and Development
VGT	Volvo Group Trucks

1 Introduction

In this part, a background description of the studied case company is introduced. Furthermore, there is an analysis of the overall problem, the study's purpose and research questions are stated and so are the delimitations of the study.

1.1 Background

This section contains a description of Knowledge Management (KM) applicability for companies. The case company is described generally and in detail regarding the focus of this study.

1.1.1 Knowledge Management in companies

Since the 1990's knowledge has been recognized as a corporate asset in the global economy (Davenport & Prusak 2000, Hansen et al. 1999). The conclusion is that knowledge must be managed as carefully as any other corporate asset. Burton-Jones (2003) argue that knowledge is a firm's biggest asset and others argue that knowledge will shape the future society (Drucker 2001, OECD 1996). According to Nonaka and Takeuchi (1995, p.74):

> *The most critical element of corporate strategy is to conceptualize a vision about what kind of knowledge should be developed and to operationalize it into a management system for implementation.*

In contrast to tangible corporate assets, knowledge assets increase as they are being used which gives the usage of knowledge a sustainable advantage (Davenport & Prusak, 2000). Another advantage of knowledge is that knowledge is hard for competitors to replicate. Unfortunately, it is also hard for companies to replicate knowledge internally (Szulanski, 1996). Consequently, in order to benefit from knowledge it has to be managed effectively.

1.1.2 Case company

Volvo Group Trucks (VGT) is owned by Volvo Group and is a parent organization to Volvo Group Trucks Technology (GTT), Volvo Group Sales & Marketing and Volvo Group Trucks Operations (GTO). Most of Volvo Group's technical development takes place at GTT and it is the research center for the entire Volvo Group. GTT is a global organization, with approximately 10.000 employees, engineering products and services on the automotive market for commercial vehicles (Volvo Group 2013a). The operations of GTT involve a set of activities, from planning and developing, to deliver complete trucks and also support the aftermarket (Volvo Group 2013b). GTT's responsibilities are divided into seven areas, Advanced Technology and Research, Complete Vehicle, Powertrain Engineering, Product Planning, Project and Range Management, Purchasing and Vehicle Engineering (Volvo Group 2013b).

Volvo Group as well as VGT and GTT have three core values: Quality, Safety and Environmental care. These core values are the areas where Volvo Group wants to be world leaders. The area of

quality emphasizes a customer centric view towards reliable goods and services and VGT aims to be the best in customer satisfaction. (Volvo Group 2013c)

1.1.3 The RnD30 improvement project at Volvo Group Trucks Technology

In order to sustain a competitive advantage GTT is running an extensive project called RnD30. This project aims to reduce costs and lead times in the Research and Development (R&D) processes by eliminate non-value adding activities. As part of this project, a KM initiative is incorporated. The KM initiative is focused on lessons learned and using knowledge from previous experiences. It is in this area this study have focused, see Figure 1. Measures have already been taken in order to implement KM strategies and tools, many of them at R&D.

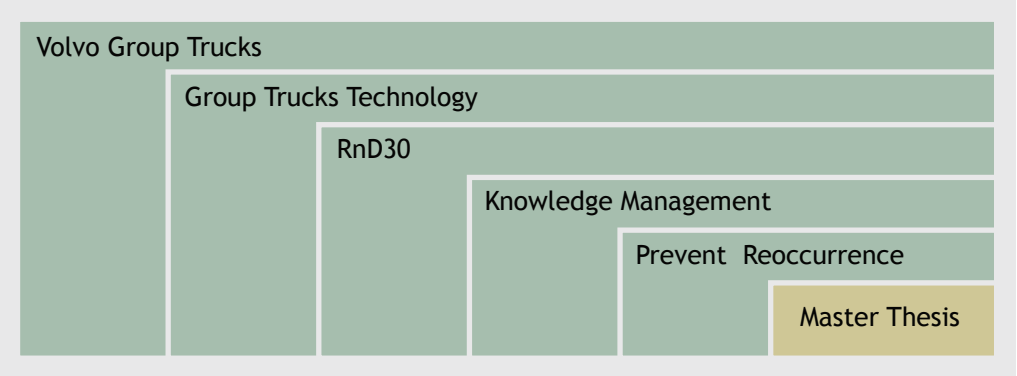

Figure 1 *The study related to the activities at VGT.*

1.1.4 Costs of poor quality

Quality is an important contributor to an organization's profit, prosperity and success (Bergman & Klefsjö 2010), see Figure 2. As a core value, quality is highly important for VGT. Lacking quality will generate costs that account for internal and/or external failure costs (Bergman & Klefsjö 2010). An example of internal failure costs is costs for scrap or rework, whereas external failure costs would be when a defective product reaches a customer, causes dissatisfaction, bad will and even warranty claims (Bergman & Klefsjö 2010). Therefore, external failures are serious matters for VGT. If a defective product is causing a significant problem for a customer, VGT has to respond and a quality improvement project is initiated.

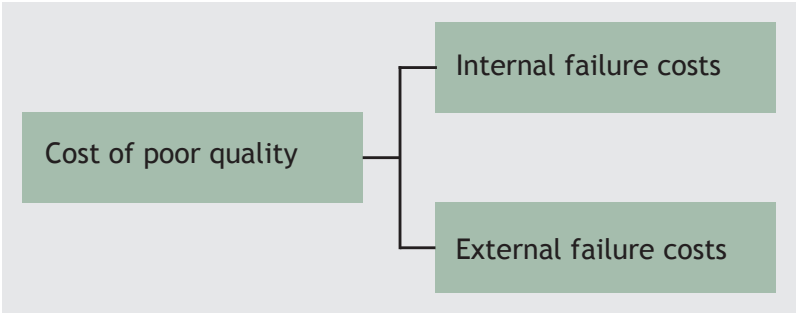

Figure 2 *Costs of poor quality. (Bergman & Klefsjö 2010, p.68)*

1.1.5 Quality Journals

Quality Journal (QJ) is VGT's name for a prioritized product or component quality improvement project initiated due to feedback from the market. An eight-step problem solving process, in this report referred to as the QJ process, defines the execution of a QJ. The QJ process is generic for VGT but there are slight differences among tools and activities in the process between different parts of the organization, e.g. between Powertrain Engineering and Vehicle Engineering. The aim is to solve the issue reported from the market as quick as possible in order to prevent other customers to be affected. The QJs are considered processes for stopping the effects of quality problems and thereafter identifying the problem root cause and finding a permanent solution for eliminating it. Quality and Customer Satisfaction department (QCS) collects market input, initiates cross-functional QJ team and leads the QJ along the QJ process. There are three different types of QJs that can be initiated. In chapter 4 a detailed description will be given to QJ types, the QJ process and the QJ setting.

1.2 Problem analysis

A brief problem analysis is provided in order to present the problem area at VGT that gives shape to the purpose of the study and explains the study's research questions.

1.2.1 Reoccurring quality issues

QJs are reactions to quality issues that have been experienced by customers. The problems have different impact on the market, and some are more crucial than others. The issues have to be prioritized and addressed. Solving the problems and helping the customers is important. Another important part is to avoid reoccurrence of the quality issues.

Despite the success of developing a solution from a number of QJ projects, VGT has experienced that some quality issues have reoccurred. This fact has made QCS interested in the KM initiative, as means for understanding how QJ knowledge can be managed in order to prevent having the same problem more than once. There is an overall target to minimize quality issues experienced by the customers, but also to reuse the knowledge obtained from a QJ as means for improving product quality. VGT have acknowledged the need to better understand how knowledge from QJs is utilized.

1.2.2 Knowledge Dissemination

Knowledge Dissemination (KD) is *"a collective term encompassing both knowledge transfer and knowledge sharing"* (Paulin 2013, p.2). KD is a crucial knowledge activity for VGT in order to understand the prerequisites for managing knowledge obtained from QJs. Since the problem solving process for QJs are generic within VGT it is of great value to grasp and understand what influence effective KD from QJs. Knowing this could give a direction in how knowledge can be managed more effective, with the ultimate goal of enhanced product quality.

1.3 Purpose

The purpose of this study is to analyze Knowledge Dissemination from product quality improvement projects in a global automotive company on an intra-organizational level. The goal is to identify factors that have an impact on the Knowledge Dissemination.

1.4 Research questions

One main research question has been developed to set the scope of this study. The main research question reflects the purpose and is examined at VGT, representing a global company in the automotive industry. The formulation of the main research question:

- What factors affects the Knowledge Dissemination from market initiated product quality improvement projects at Volvo Group Trucks?

In order to understand the KD and identify the factors, the participating actors are crucial to identify. Assuming that the product quality improvement project team obtains knowledge about the quality issue they solved and has an intention to disseminate it, the appropriate recipients of knowledge have to be known. Finding the right recipients in a big organization might be complex and consequently worth investigating. Once the knowledge recipients are identified, it is possible to investigate the KD, and identify factors that hinder and facilitate the dissemination. Identifying theses factors are important in order to understand and be able to improve the KD.

Based on this reasoning, the main research question leads to two underlying research questions. They will aid in answering the main research question. The two underlying research questions are:

- RQ1: Who are the recipients of the knowledge disseminated from market initiated product quality improvement projects at Volvo Group Trucks?

- RQ2: What factors affect the Knowledge Dissemination between market initiated product quality improvement projects and identified recipients at Volvo Group Trucks?

1.5 Delimitations

VGT is a company with presence around the world but this study is limited to QJs only run by QCS at GTT on the Gothenburg site. All data collection was also performed at the Gothenburg site. Furthermore, possible KD to suppliers from QJs is not included in the scope of this study. These delimitations were made to ease the data collection.

The study is focused on identifying factors affecting the KD and limited effort is put into ranking or benchmarking the factors against each other. Moreover, the factors impact on KD is studied and not the factors influence on each other. Also limited effort was put into analyzing the difference in factors or their influence between the three different types of QJs. These delimitations were set because of the limited time available for the study. Identifying and prioritize the factors would require more data, both qualitative and quantitative. Furthermore this study neither assess the solutions developed by the QJs nor if the correct problem root cause was found.

The quality improvement processes are sometimes different between the various VGT Brands e.g. Volvo and Renault. Therefore, only processes linked the Volvo truck brand is included in the study. Moreover, only projects aimed at quality issues regarding Powertrain Engineering are investigated. This delimitation was made since the process used for QJs aimed at Powertrain Engineering are expected to be implemented for QJs also aimed at Vehicle Engineering. The process used towards Powertrain Engineering is also considered more mature, according to GTT.

2 Methodology

In this chapter considerations regarding the researchers' scientific perspective and the design of the study are explained. Insights are given to the study's ethical considerations and how the quality of this research is assessed. Furthermore, used methods and tools are presented together with the study's line of action.

2.1 Research strategy

The research strategy of this study has been based on a hermeneutic approach. As a qualitative study the emphasis was on words and understanding human behavior rather than testing a hypothesis with quantitative measures (Bryman & Bell 2011). Limited effort was therefore put into gathering quantitative data.

2.1.1 From data to theories

Regarding the role of theory an inductive approach was primarily chosen. This implies that data first are gathered and thereafter theories are developed. This approach is in line with research questions of an understanding nature. However, there are some influences of deductive elements since the research was based on KM theory and further data collection was carried out to confirm formulated theories (Bryman & Bell 2011).

2.1.2 The difference between studying people and objects

An epistemological position of interpretivism has been used regarding what is considered acceptable knowledge. Bryman and Bell (2011) writes that interpretivism implies that there is a difference between people and objects of the natural sciences, arguing that the subjective meaning of social action have to be considered. If assumed there are only subjective truths about social interactions measures to improve objectivity can be taken.

2.1.3 The social context is affected by the people in it

The chosen ontological orientation was based on constructionism, which asserts that social actors continually accomplish and influence social phenomena and their meanings. According to Bryman and Bell (2011) this means that since the people acting within a social context actually decide what is truth at every point in time, it is impossible to draw definitive conclusions about social reality.

2.2 Research design

This study was performed as a one-time single organization case study at VGT between September 2013 and January 2014. The case study research design is acknowledge as common and widely used in business research (Eisenhardt & Graebner 2007). The choice of research design was based on its alignment with the overall purpose of the study. Performing a case study and keeping the research questions narrow made it possible to deeply explore the studied area.

2.2.1 Level of analysis
Within this study the primary level of the analysis have been on a group level, i.e. intra-organizational level (Bryman & Bell 2011). This means the study's focus have not been on individuals but on different types of groupings e.g. the QJ team and the involved departments.

2.2.2 Data collection and analysis based on Grounded theory
The relationship between data and analysis in this study have been inspired by the Grounded theory. Data was hence used to develop new theory, and data collection and analysis was performed simultaneously and iteratively. The collected data was coded into concepts and labeled for the analysis. (Bryman & Bell 2011)

2.3 Research methodology
In this section the study's line of action will be explained in detail. The study has been planned based on Bryman and Bell's (2011) work phases for qualitative research. The involved phases are shown in Figure 3.

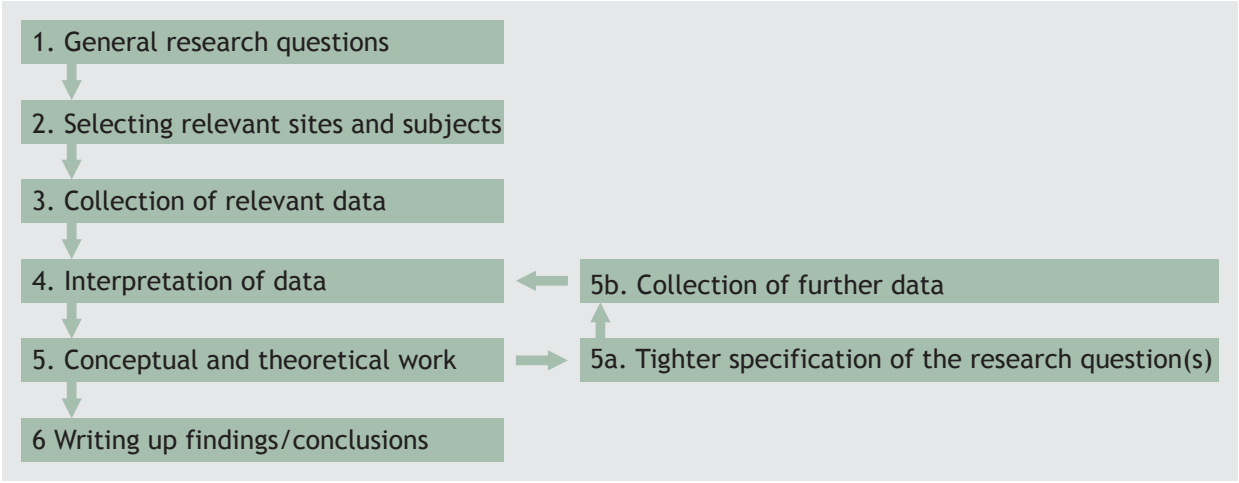

Figure 3 *Main phases of qualitative research. (Bryman & Bell 2011, p.390)*

This study was started with a pre-study aimed at tighten the specification of the initial research question and break it down into manageable sub questions. In the pre-study step 1 to 5a were performed. The main study was started after the initial loop, with the specific research questions more defined, and continued through step 1 to 6. A representation of the general time plan and research phases are shown in Appendix 1.

2.3.1 Pre-study
After agreeing upon the main objectives for the study together with supervisors at GTT and Chalmers, the pre-study begun. The purpose of the pre-study was to increase the researchers KM understanding, familiarize with VGT and develop the research questions. A literature study on KM theory was started and continued throughout the whole pre-study in parallel with the other tasks. The choice of literature included books, articles and reports. Literature was mainly searched for at the Chalmers library, including its databases, and Google Scholar. Other literature was found via reference lists in read literature and by personal recommendations. Commonly used search words, also in combination with each other, were: Knowledge Management, knowledge transfer, knowledge sharing, product development, automotive industry, quality, project, barriers, factors.
To understand the VGT organization structure and the main processes the supervisor at GTT was

consulted, company presentation material was read and the researchers participated in online learning courses for new employees. Together with the supervisor at GTT, meetings were held with employees from QCS, R&D and other departments to furthermore increase the understanding of the processes in focus. These meetings also gave new insights regarding the main idea of the study. Throughout the pre-study the researchers also discussed research strategy, research methodology, research questions and the main idea of the study with GTT and Chalmers supervisors, a KM specialist at GTT and a PhD at Chalmers with knowledge within the academic field.

2.3.2 Main study

With the researchers improved KM understanding, knowledge about VGT, information about problems, possible value for VGT and input on general feasibility it was possible to specify the research questions and initialize the main-study. This section will in detail describe the process of the main study and the methods used. The main study was divided into two phases. The first phase included planning the data collection, deciding on which reference projects to study and finding relevant interviewees. In the second phase the data collection was conducted, the data was analyzed and the analysis was verified.

2.3.2.1 Choice of reference project

To conduct the study, one reference project was picked from each of the three different types of QJs at VGT, see chapter 4 for an explanation of the different project types. The reason for choosing a reference project from each type of QJ project was to get a more complete understanding of QJ projects and increase the likelihood for general conclusions regarding the QJ process. Looking into three reference projects, the time was sufficient to gather rich data and study these projects thoroughly. Also by focusing on three specific projects it was possible to compare data from different employees involved in the same project and thereby get a more complete picture of each project. The three studied QJs were labeled QJA, QJB, QJC based on their type.

A requirement for the chosen reference QJs was that they had concluded on the QJ created knowledge and disseminated most of it. Therefore, all studied projects have at least reached the 6D step of the QJ process, see chapter 4 for an explanation of the project process. It was also ensured, that the reference projects had reached the 6D step during 2013 to increase the likelihood of interviewees being available at the Gothenburg site and having their project fresh in mind. The choice to look at projects where KD had occurred also made it possible to interview sources and recipients regarding the same KD. Three QJs fulfilling these requirements, as well as being considered as representative by QCS managers, were selected for the study.

2.3.2.2 Identifying interviewees

When the choice of reference QJs was made, suitable interviewees were identified and selected. The subjects for interviews were chosen considering their role, responsibility and involvement in the project. The different roles involved are explained in chapter 4. A condition was also that the individuals were present during the KD. Interviews were conducted with individuals on both the source and recipient end of the KD.

In the QJA, six persons in total were interviewed. Two of them represented QCS, the QJA-holder and a PMQJ. Three interviewees were working at R&D, the engineering leader and two design engineers. There was also one interviewee from GTO. Eight interviews were conducted regarding the QJB. From QCS, two PMQJs were interviewed. Three employees from R&D were interviewed: an R&D auditor, a GCR, and a design engineer. From Aftermarket, a Product Quality Manager took part in the interview. Furthermore, a Purchasing employee was interviewed as well as a safety investigator. In the QJC, interviews were held with two individuals from QCS, a PMQJ and a PQL.

From R&D, three interviews were held with two different design engineers and one engineering leader. There was also one interview conducted with a Purchasing employee.

To increase the likelihood of developing universally conforming recommendations, data was also gathered from individuals involved in QJs other than the reference ones to enable a comparison of the results and validate the findings. In total three interviews of this kind were conducted, all of interviews were conducted with PQLs from QCS.

2.3.2.3 Data collection and interview methodology

Interviews are a well-established method for qualitative data acquisition. The access to subjects was assumed due to the study being anchored at a high level within VGT. Using qualitative interviews, the goal was to get deep understanding of subjects' experiences and subjective opinions. Personal interviews have been chosen to comfort subjects in voicing their thoughts, securing rich and trustworthy data. An additional advantage with personal interviews is the possibility of also gathering data from social cues (Opdenakker 2006). Social cues could be expressed in e.g. the body language and the voice of the interviewee and it can be valuable input if the interviewee is seen as a subject (Opdenakker 2006). When performing personal interviews it is also essential to ask probing questions to go beneath surface appearances since the subject probably interpret things differently than the interviewer first thinks (Bryman & Bell 2011). However, the risks associated with personal interviews are that the interviewer could influence the interviewee (Opdenakker 2006). This was mitigated through acknowledging the risk and using a written interview guide during all interviews. The interview guide was also used in order to explain e.g. the study's purpose in an equal way for all interviewees before the interviews begun, see Appendix 2. The interview questions was structured with respect to the research framework, presented in chapter 3. Before the main data collection begun, a test interview was performed to evaluate the interview structure and the questions. Adjustments were done to better tailor the questions to the interviewees.

The data collection was started by interviewing subjects from the knowledge source, i.e. the QJ. The researchers' intention was to let QJ team individuals state appropriate knowledge recipients and then assess the KD from the recipient's perspective. The decision to start with the source was made since the knowledge is created during the QJ when the recipient might not be known yet. Furthermore, since the QCS department initiates the QJs it was easy to get in contact with QJ team members. All interviews were semi-structured and followed the interview guide. Semi-structured interviews were chosen because it gives an opportunity to deviate from the structured questions if an interesting topic is brought up. Therefore, the questions were seldom asked in the exact same order and questions were sometimes left out to make room for investigating topics of particular interest.

In total, 23 personal interviews were carried out and data was collected in new interviews until the researchers perceived a convergence in the data. 21 of them were conducted face-to-face, one was conducted via telephone and one via videoconference. The reason for having two non face-to-face interviews was due to practical issues as the interviewees were not present at the Gothenburg site at the time for the interview. Two of the interviews were ended premature since the obtained data was not conforming of the expected extent and quality. The interviews had an average duration of 1.5 hours. During the interview session one researcher took notes and the other conducted the actual interview. All interviews were recorded and transcribed to ensure to capture as much detailed data as possible. According to Bryman and Bell (2011) writing transcripts takes approximately six longer than the actual interview.

Apart from the interviews, the researchers have spent a considerable time in the building where the QCS interviewees do their daily work. This implies that informal conversations with interviewees

have taken place, discussions have been overheard and other observations, with or without relevance, have been made. Also, the researchers attended two main QJ meetings in order to observe how they were practically conducted. These methods have increased the researchers understanding of the studied context and probably to some extent influenced the data collected. However, none of the methods have generated any documentation used as data, although it is likely that the researchers' presence could have an impact on the analysis and the conclusions made.

2.3.2.4 Analysis

As described earlier, the data collection and analysis was done in tandem in accordance with the Grounded theory. Data was collected through interviews and after each interview, time was used to reflect on the interview by revisiting notes and the semi finished transcript. During these reflective sessions concepts for potentially significant factors and theory was compiled and labeled. In the beginning of the data collection these concepts was vague but as the interviews continued concepts was refined and confirmed by more data. New concepts were also continuously added as the study progressed. Both potential and verified concepts were kept in a continuously updated document.

A similar coding process occurred after all interviews had been conducted and all transcripts had been finalized. The transcripts was printed and cut into pieces while being coded into concepts. The concepts were developed by gathering corresponding data together and label the concepts with post-IT notes. These concepts were compared to the already made concepts and higher-level categories could be developed. In the end of the analysis, a number of defined categories had emerged with concepts and data supporting them.

Paulin's (2013) research model has been used as the research framework of this study in order to aid the understanding of KD, design interviews and structure the analysis. The framework was chosen since it was considered comprehensive and concrete. Also, it had been developed from other similar models of KD and it has been used for analyzing KD in a similar company setting (product realizing multinational corporations) as this study. Even though the researchers' supervisor from Chalmers has developed the framework, the influence of this choice was considered to have no significant impact on the study. The framework was used to structure the analysis and give perspective on how to label factors. Regardless of the choice of research framework, the collected data would probably reveal the same factors, but from another perspective. The research framework is explained in chapter 3.

2.3.2.5 Validation of the analysis

In order to validate the analysis two unstructured interviews with personnel possessing general insight of the studied processes and groups were conducted. This was an additional effort made to confirm the credibility since the main study's interviews had already continued until the collected data converged.

2.4 Limitations of methodology

As a qualitative one-time case study focused on a social context the findings cannot be truly objective. It is impossible to study the social world and decide what is the absolute truth since the social world is constantly in change. Also, the researchers own values will influence the interpretation of the social scene to some extent. (Bryman & Bell 2011)

Furthermore, the interviewers' interview skill will affect the performance of interviews as a method. For example, if subjects feel uncomfortable with the situation the data they contribute with might be sparse and unreliable. Another drawback when using interviews as the data collection method

is that only a limited number of interviews are feasible since they require a lot of resources and a lot of time from both researchers and subjects. The risk is to only interpret the social scene through the eyes of a few of the individuals in that scene. The sample of interview subjects is therefore important. Efforts have been made to ensure that the interviewed sample spanned over all different roles participating in the studied QJs.

2.5 Research ethics

In business research there are four main issues for considering ethics: harm to participants, lack of informed consent, invasion of privacy and deception (Diener & Crandall 1978 in Bryman & Bell 2011). In this study all issues were addressed and treated as important. This section describes how the study took the four ethical considerations into account.

2.5.1 Harm to participants

This study can guarantee that no physical harm affected the participants or anybody else. However, the biggest risk of harm to participants in this study was psychological. One source of harm would be if the participants got connected to critical statements about VGT, their job, managers or colleagues, leading to negative consequences for them. To address the risk of connecting critical statements to the participants, the highest possible extent of anonymity was strived for. However, it cannot be guaranteed that no one will know who participated in the research. It is clearly difficult to interview subjects at their work, ensuring that no one else knows they are taking part in the study. On the other hand, the participants was guaranteed that no statement would be possible be trace to a single individual. Documented answers were separated from the participants name or any other information that could reveal their identity. In order to do this, the documentation was identified with a number that had nothing to do with the participant instead of the participant's name. Recorded data was also held confidential to all but the researchers.

Another source of psychological harm would be if the questions recall bad memories or experiences, or if the questions make the participant feel inadequate or in any sense uneasy. Whether the questions evokes an uneasy feeling or recalls bad memories is a subjective issue that can't be addressed in a standardized way. To avoid it to the largest possible extent the interview questions were revised after a test interview with a non-participating individual. The participants were also told in advance that they could stop the interview if they wanted, without explanation. They could also skip questions, without explaining their reason. Also, since the study regards quality issues, which might be a sensitive topic for some participants, the alternatives of stopping the interview or skipping questions were necessary to offer. It was also emphasized that the study was not about finding scapegoats and individual mistakes, but rather understand the circumstances. However, no interview was stopped by the interviewees nor was any questions skipped in the study.

2.5.2 Lack of informed consent

The researchers should thoroughly explain the study to potential participants in order to get their consent of participation, according to Bryman and Bell (2011). In this study the participants were informed about: the purpose and outline of the study, who was the supervisor, the researchers academic background, how the collected data would be used in order to meet the purpose and answer the research questions. They were also informed about their right to stop the interview and skip questions, and that collected data would be treated anonymously and nothing they said would be traceable back to themselves. The estimated time needed was stated in the interview invitation but it was repeated in the introduction to the interview. All this information was provided before the interview started. Since it is hard to judge how much information is sufficient for the participants to make a sound decision of consent (Bryman & Bell 2011), it was also time available

for the participants before and after the interview to ask questions. The recorder was started after the informative introduction and only after approval by the participants. It was communicated when the recorder was being used.

2.5.3 Invasion of privacy

Even when the participants have a good understanding of the research and had agreed to take part in the study, it is still important to protect their privacy. Participants were reminded that they at any time could revoke their participation and choose to not answer further questions. They were also aware of how data was being documented and how it would be used in the research. All participants also had the opportunity to get back to the researchers if they wanted to comment upon something or add something in regard to their interview afterwards. The interview questions regarded KD, the QJ process and the research framework exclusively. No other topic, e.g. personal matters, was addressed during the interviews.

2.5.4 Deception

The purpose of the study should be clear and honest and performed with integrity, representing the research as something it is not would be deception (Bryman & Bell, 2003). The researchers' role was therefore clearly stated and agreed upon together with VGT at the start of the study. The study has also emphasized its true purpose in all means of data collection. The participants have been informed about how data will be used and they were also invited to take part of the outcome and final findings of the study.

2.6 Trustworthiness

Trustworthiness has been chosen as the criteria to assess the quality of this qualitative study. This is a common way to assess qualitative studies, which acknowledge that there are no absolute truths about the social world (Guba & Lincoln 1994 in Bryman & Bell 2011). Furthermore, Dubois and Gadde (2013) state that criteria originally developed for quantitative research (construct validity, internal validity, external validity and reliability) are not suitable for evaluating deep-probing qualitative studies. The four aspects of trustworthiness are (Bryman & Bell 2011, p.395):

- Credibility - How believable are the findings?
- Transferability - Do the findings apply to other contexts?
- Dependability - Are the findings likely to apply at other times?
- Confirmability - Has the investigator allowed his or her values to intrude to a high degree?

There are some common critique against qualitative research methods stating that they are too subjective, difficult to replicate, hard to generalize and lacks transparency (Bryman & Bell 2011). This critique is relevant also in regard to this study. Beneath the aspects of trustworthiness are described and performed counter actions are explained.

2.6.1 Credibility

Credibility is a measure on how well the study's findings correlate with reality. To ensure credibility the researchers tried to follow good practice. For example, if feeling unclear of the meaning of an interview statement the interviewee was asked to explain the statement again. Also both researchers attended the majority of the interviews so the interpretation of the data could be discussed. Triangulation made sure that the study's findings were crosschecked by a different source of data by performing two additional interviews with new interviewees. The study's findings were also presented during a presentation for personnel working within the studied context and for participants of the study followed by discussions and questions. It is however questionable if the

studied subjects can be used to validate the research findings without bias. The researchers were aware of this issue at the time of the presentation and could act accordingly.

2.6.2 Transferability

Transferability is a about the study's findings generalizability to other contexts. Since this is a one-organizational case study at VGT and the study is based on a fairly small amount of personal interviews the findings will likely be limited to the studied context. The transferability to other contexts is therefore questionable for the case study, which is a common issue (Bryman & Bell 2011). To maximize the transferability of the study, the studied context was described in detail to help others assess if the findings do apply to their context.

2.6.3 Dependability

Whether a study is possible to replicate at another time and still generate the same findings is the main aspect of dependability. Due to its subjectiveness this can be hard for a qualitative study. Naturally it will be difficult for someone to perform this study in the same way, with the same subjects and at the same company. Subjects are anonymous and of a fairly limited number meaning a single changed individual can have a rather large impact on the findings. Also the researchers themselves are not totally objective in their interpretations. To improve the dependability of this study records was written during the study of the reasoning and the process of all conducted phases. The researchers have also tried to give a rich description of the study's process in this report.

2.6.4 Confirmability

Confirmability regards if the researchers have been as objective as possible, even if complete objectivity is impossible, when conducting the study and when formulating the findings. To ensure that the researchers own values affected the study as little as possible almost all data collection was performed by both researchers present, turns was taken interviewing and taking notes. Also, full transcriptions were written. The researchers in collaboration also carried out all data analysis, in order to mitigate the chance for only interpreting a piece data from one perspective. Throughout the study the researchers tried to maintain as objective as possible, e.g. being aware of possible attempts to influence the study by VGT individuals engaged in internal politics or by VGT individuals possibly with a lot at stake depending on the study's findings. The researchers did not embraced thoughts or suggestions from others regarding the study's findings without having clear support in the collected data.

3 Theory

The theoretical background used in the study is presented in this part. The concept of knowledge is introduced and defined. General insight into KM considerations and the research area are given together with the researchers' view on KM and KD. Lastly, the research framework used in the study is presented.

3.1 Conceptualizing and defining knowledge

In order to understand the meaning and complexity of knowledge, one can compare it with the related notions, data and information, which are more familiar and more comprehensive terms. This way to conceptualize knowledge is common (Paulin 2013). Data, information and knowledge are not interchangeable concepts but by acknowledging the difference in meaning of them, they can be related and their transformation into each other can be understood (Davenport & Prusak 2000). The following definitions are based upon the work of Davenport and Prusak (2000).

Data *"is a set of discrete, objective facts about events"* (Davenport & Prusak 2000, p.2). It has no inherent meaning and provides neither judgment nor interpretation. However, data can be processed and constitute the raw material of decision-making and it is possible to store. Although data is possible to transform into information, there is a risk of gathering too much.

Information is described as a message with the intention to *"shape the receiver"*. As a contrast to data, information has meaning, in other words, data is transformed into information by adding meaning. This transformation happens when the source provides a context to data, categorize the data, calculate it, correct it and/or condense it. The intention of informing is to have an effect on the receiver's judgment and behavior.

Knowledge can be created from information in a similar way as meaning added to data becomes information. This happens through comparison and connection of information but also by elaborating on consequences of information and having conversations about it. The value of knowledge, compared to data and information, is the closeness to taking action. Knowledge is more complex than the previous concepts and the following definition by Davenport and Prusak (2000, p.5) illustrate the complexity of its meaning:

> *Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of the owners. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms.*

Nonaka (1994, p.15) defines knowledge as *"justified true belief"* and also distinguishes it from information. Nissen (2002) uses Davenport and Prusak's (1998) conceptualization of knowledge in a "*knowledge hierarchy triangle*" and illustrate it with the dimensions actionability and abundance, see Figure 4. The triangle shows how the abundance level decreases when the lower hierarchy levels are transforming into higher hierarchy. The dimension of actionability illustrates how the knowledge is more supportive to an action than data and information.

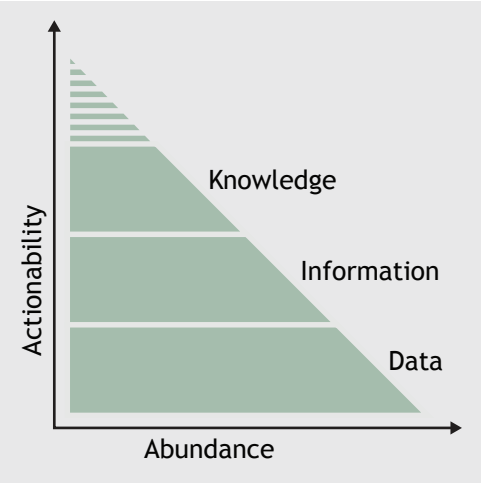

Figure 4 *The knowledge hierarchy. (Nissen 2002, p.253)*

As can be seen in Figure 4, the top of the triangle is missing. Davenport and Prusak (2000), discuss *"higher-order concepts*", e.g. wisdom, but choose to exclude those from the conceptualization for practical reasons. This study will not explore higher-order concepts but instead, similarly as Davenport and Prusak (2000) and Nissen (2002), conclude that knowledge is essential in decision-making and for taking actions.

3.2 Knowledge dimensions and conversions

Knowledge can generally be categorized into two different dimensions, namely explicit knowledge and tacit knowledge. Nonaka and Takeuchi (1995) states that explicit knowledge is a view of knowledge as something formal that can easily be expressed in words and numbers and shared via written documents and databases. Tacit knowledge is in contrast not easily visible and expressible, e.g. the know-how of a craftsman. Therefore, tacit knowledge is hard to verbalize and communicate to others as well as formalize and share in a systematic manner. Regarding tacit knowledge Polanyi (1966, p.4) states "*we can know more than we can tell*". For tacit knowledge to be shared widely within an organization it needs to be converted into words and numbers. However, knowledge expressed this way will not fully capture the original knowledge. Whether all knowledge is either explicit or tacit is a controversy and not all authors agree on a clear division. For example Shin et al. (2001, p.337) states "*the boundary between explicit and tacit knowledge, however, is not clear*". Explicit and tacit Knowledge can be converted in four ways, from tacit to explicit, explicit to explicit, explicit to tacit and from tacit to tacit knowledge. These four modes of knowledge conversion are socialization, externalization, combination and internalization, see Figure 5. Knowledge created by socialization is based on shared experience, e.g. via observation or interacting with customers, and can be shared mental models and technical skills e.g. how to perform an epic split or develop ideas for improvement. Externalization is a process in which tacit knowledge becomes explicit in the form of e.g. concepts, hypotheses or metaphors. An example would be generating a product concept by collective reflection. Combination involves combining and categorizing explicit knowledge through media like documents, databases, meetings, etc. to form new knowledge.

Middle managers breaking down corporate visions to make them more operationalized or to take product concepts and integrate them into a corporate vision are two examples. Internalization is when knowledge created in from of socialization, externalization and combination is internalized as tacit knowledge in individuals as mental models or technical skills. This is closely related to "*learning by doing*" and an example would be a team that have learned from previous experiences and changed how they conduct projects. (Nonaka & Takeuchi 1995)

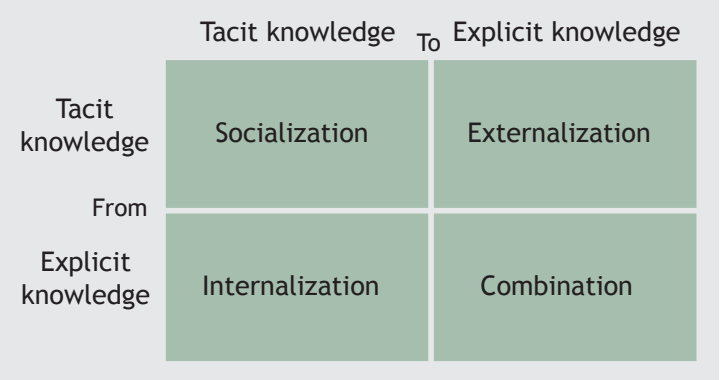

Figure 5 *Four modes of knowledge conversion. (Nonaka & Takeuchi 1995, p.62)*

Organizational knowledge is mainly created in the continuous interaction between tacit and explicit knowledge. This knowledge creation process is made up of the knowledge shifting between the four knowledge conversion modes like the spiral illustrated in Figure 6. Socialization is however, a limited form of knowledge creation since the knowledge needs to be explicit to be easily shared within the organization. So is also the combination process because merely compiling explicit knowledge in e.g. a document does not necessarily extend the organization's knowledge. (Nonaka & Takeuchi 1995)

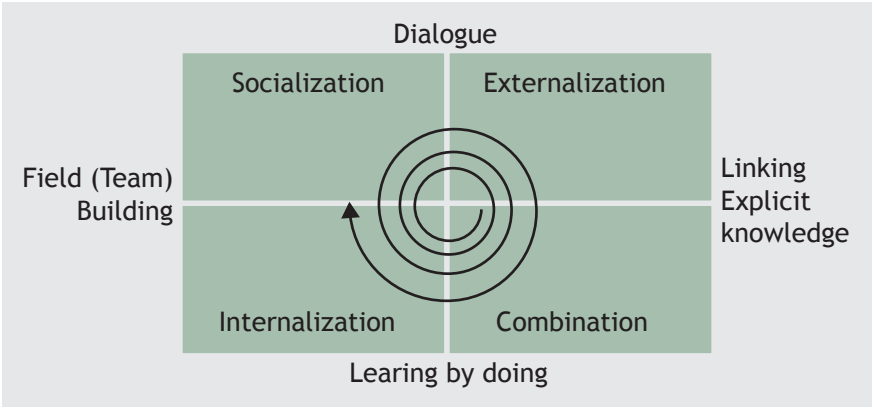

Figure 6 *The knowledge spiral. (Nonaka & Takeuchi 1995, p.71)*

3.3 Views on knowledge

The views of knowledge in literature are diverse and somewhat ambidextrous. The different views upon knowledge are important to address when KM systems are developed (Alavi & Leidner 2001) and when KM performance is evaluated (Chang Lee et al. 2005). Alavi and Leidner (2001) present different perspectives of knowledge and their implication for KM and KM systems. Chang Lee et al. (2005) use an excerpt of Alavi and Leidner's (2001) summary, which is shown in Table 1.

Table 1 *Different perspectives of knowledge. (Chang Lee et al. 2005, p.470)*

Perspectives of knowledge	Implications for KM
State of mind - Knowledge is the state of knowing and understanding	KM involves enhancing individual's learning and understanding through provision of information
Object - Knowledge is an object to be stored and manipulated	Key KM issue is building and managing knowledge stocks
Process - Knowledge is a process of applying expertise	KM focus is on knowledge flows and the process of creation, sharing, and distributing knowledge
Access to information - Knowledge is a condition of access to information	KM focus is organized access to and retrieval of content
Capability - Knowledge is the potential to influence action	KM is about building core competencies and understanding strategic knowhow

Sveiby (2007) also elaborates on knowledge as an object and presents an opposing view, knowledge as a subjective contextual construct. The former view implies that "*knowledge can be packed, stored and retrieved with relative ease*" (Paulin 2013, p.5), but this view is criticized by many authors according to Sveiby (2007). Knowledge as a subjective social construct is based on Polanyi's (1958) argument that "*knowledge is constructed in a social context and that it cannot be separated from the individual and the context*" (Sveiby 2007 p.1638). This view implies that the context of creating knowledge is where management should make an effort. Regardless the view on knowledge, the distinction between information and knowledge or tacit and explicit knowledge is still central according to Sveiby (2007).

3.4 Knowledge Management

Knowledge Management is defined as "*efficient handling of information and resources within a commercial organization*" according to Oxford Dictionaries (2013). Several authors describes it as locating knowledge within a firm and use it where it is needed, in other words "*know what you know*" (Davenport & Prusak 2000, O'Dell & Grayson 1998, Burton-Jones 2003). Burton-Jones (2003) states that firms must enhance knowledge as a their biggest corporate asset. In order to do so, companies must be aware of their knowledge assets as well as closing the knowledge gaps. Closing the gaps can be facilitated with the use of knowledge maps, see Figure 7.

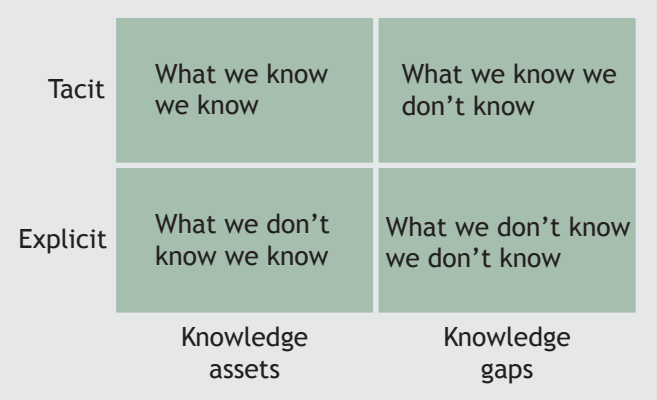

Figure 7 *Mapping organizational knowledge. (Burton-Jones 2003, p.144)*

KM is often described in a set of events or activities. Nissen et al. (2000) call this set of knowledge activities the KM life cycle and made a comparison based on different authors, see Table 2.

Similarly, Alavi and Leidner (2001) describe KM as a process of activities and argue that the labels of activities might differ as well as their number, but the underlying concept described is about the same. They also argue that there is a minimum of four basic activities namely: creation, storage/retrieval, transfer and application. As have been mentioned previously, this study will mainly focus on the transfer/sharing (dissemination) phase within the KM research field.

Table 2 *KM life cycle models. (Nissen et al. 2000 p.30)*

Model	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Nissen	Capture	Organize	Formalize	Distribute	Apply	-
Despres and Chauvel	Create	Map/bundle	Store	Share/transfer	Reuse	Evolve
Gartner Group	Create	Organize	Capture	Access	Use	-
Davenport & Prusak	Generate	-	Codify	Transfer	-	-
Amalgamated	Create	Organize	Formalize	Distribute	Apply	Evolve

In Nonaka (1994), the organizational knowledge creating process is described as an ontological dimension of knowledge that indicates the amplitude of knowledge created by individuals in the organization. The amplitude reaches through four levels of interaction: individual, group, organizational and inter-organizational, see Figure 8. Choo and Neto (2010) relate the interaction levels with different knowledge processes in their framework for enabling conditions for KM. The interaction level in focus in this study will be on group level, i.e. intra-organizational, team or department level.

Figure 8 *Interaction levels.*

Furthermore, KM practices can be divided into two different strategies, codification and personalization (Hansen et al. 1999). The codification strategy emphasis that knowledge is stored centrally, e.g. in a database, and made available to all employees. The strategy of personalization instead highlights knowledge to be communicated between individuals. Hansen et al. (1999) argues that one strategy should preferably dominate the other in a company. The "*80-20 rule*" is mentioned as good properties. One aspect central in the choice of strategy is how to use IT-systems. For instance, the IT system could be used to store explicit knowledge, or it could facilitate mapping the organizational knowledge. However, possessing technology does not per se imply the use of it or effective KM (Davenport & Prusak 2000) but it can be regarded as a facilitator (Goh 2002) or even an enabler for KM (O'Dell & Grayson 1998).

3.5 Knowledge Dissemination

The terms knowledge transfer and knowledge sharing are more commonly used than Knowledge Dissemination, however the distinction between the notions are not clear and some authors use them synonymously (Paulin & Suneson 2012). The difference in ontological and epistemological perspective of knowledge, knowledge as an object or knowledge as a subjective contextual construct, might have an impact on the use of the notions knowledge transfer and knowledge sharing in the literature according to Paulin and Suneson (2012). In order to avoid taking a stand in the epistemological and ontological view upon knowledge and to be able to address a broad knowledge perspective, this study has used the encompassed notion Knowledge Dissemination.

Disseminating knowledge with considered success is not the same thing as merely making it available (Davenport & Prusak 2000). Cummings and Teng (2003) use the definition of knowledge internalization for judging the success of KD. A recipient that fully internalize knowledge gets ownership of it, commitment to it and satisfaction with it, and when this happens knowledge can ultimately be used (Cummings & Teng 2003). Davenport and Prusak (2000) has a similar idea, they mean that dissemination of knowledge must involve absorption by recipient in order to even be considered KD. They further argue that KD is not adding value to the organizations if it does not lead to use, change, development etc. These ideas of successful KD correlate to the hierarchy triangle, the capability perspective of knowledge, and the KM processes earlier presented.

KD is part of KM theories but it is also an important element in the theories of learning organizations (Garvin 1993, Goh 2002). Learning in an organization is a requirement to continuously improve (Garvin 1993), and continuous improvement is vital in quality strategies (Bergman & Klefsjö 2010). Garvin (1993) also mentions "*learning from past experiences*" as an element in building a learning organization. This study has however only focused on KD in relation to KM.

As for communication between individuals, KD can also be affected by different factors. Within the KM research field, KD has been widely explored. A lot of literature regarding influencing factors in KD has been written in recent years. Some examples are: Davenport and Prusak (2000), Cummings and Teng (2003), Cummings and Teng (2006), Riege (2005), Riege (2007), Søndergaard et al. (2007), Duan et al. (2010) and Wang and Noe (2010). Factors can have a negative impact on KD. In that case Davenport and Prusak (2000) call them "*frictions*" and argue that they can slow down or prevents KD activities. Other words for these negative factors are hinders, noise, barriers, obstacles and constraints. Factors having a positive influence on KD are for example called enablers and facilitators. Based on Cummings and Teng's (2003) paper it is possible to view the factors' influence on KD success as linear or curvilinear. Figure 9 illustrates different types of factors.

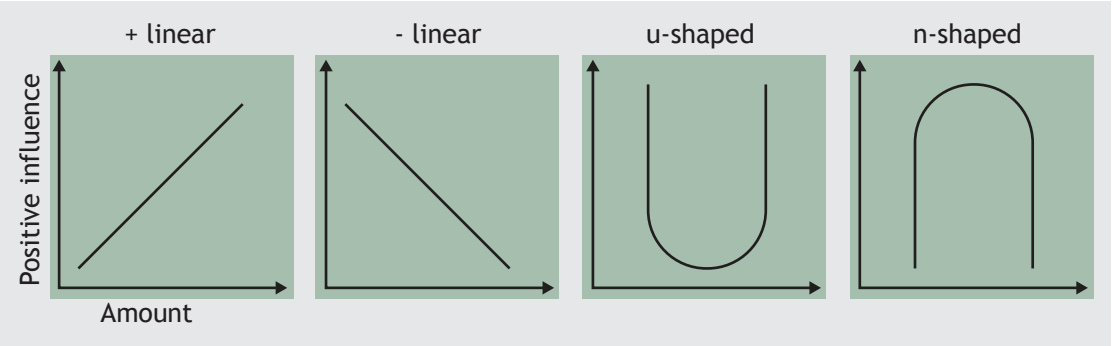

Figure 9 *Types of factors influencing KD.*

3.6 Research framework

The research framework used in this study is a research model developed by Paulin (2013). Paulin's (2013) KD model synthesize Shannon and Weaver's (1949) communications model for machines with Lindkvist's (2001) linear communications model adapted for intra-organizational communication between R&D projects (also based on the model by Shannon and Weaver (1949)) and Cummings and Teng's (2003) research framework for key factors affecting KD success on both domestic and international R&D partners. The research framework is based on seven components: Actors (including both Source and Recipient), Content, Media, Activity and Context. Paulin (2013) used the research model to group factors influencing KD. Figure 10 illustrates the framework.

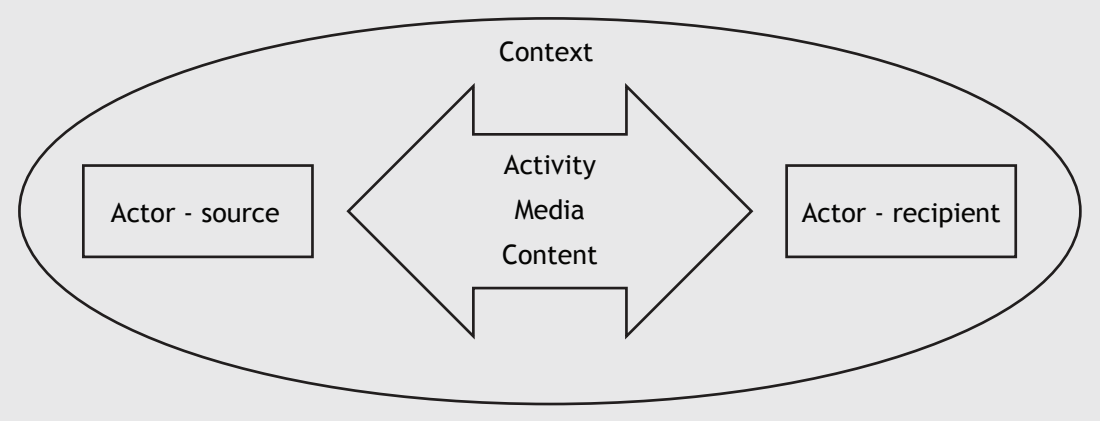

Figure 10 *The research framework. (Paulin 2013, p.21)*

In the research framework the component Source address influencing factors on the source side of KD while Recipient is about the receiving side of the KD. The source of knowledge is predefined as a QJ in this study and the recipient is the department(s) or function(s) defined and addressed by the source. The component Content is about the disseminated knowledge itself, i.e. the message that will result in an action. The component Media is the element in which the KD takes place, for instance via personal interaction or through a database. The Activity component includes the activity of KD between the actors, e.g. how often they meet. Lastly, Context is the component in regard to the environment in which the KD takes place. Since the study investigate KD in product quality improvement projects, the context will reflect this setting. The double arrow in the research framework illustrates the two-way communication between the actors. This communication allows feedback to loop back and forth, making it possible for the source to tailor the knowledge content for a specific recipient.

4 The studied area

This chapter describes processes, tools and other circumstances to give an understanding of the studied area at VGT. Explained are the different types of QJs, identified quality problems addressed in the studied QJs, the QJ process itself, roles involved in the cross functional QJ teams, tools used during the QJs as well as characteristics of important meetings.

4.1 Types of Quality Journals

All QJs share the same purpose and follows the same process, but QJs can be more or less critical for VGT. Therefore, there are three different types of QJs with different levels of prioritization. The different QJs are called Quality Journals type C (QJC), Quality journals type B (QJB) and Quality journals type A (QJA) by the researchers. QJCs are the normal and most common type of QJs. QJBs are more critical than QJCs and can deal with possible safety concerns. In QJBs an upper level group will decide whether the QJB should continue to be treated like a QJB or be downgraded to a QJC. QJAs share the highest type of QJ priority together with QJBs and deals with the most complex and costly quality problems. The QJAs are initiated by an upper level steering committee and lead by a so-called QJA holder with full authority to obtain desired resources. A QJA can include a number of QJCs. Table 3 illustrates the different types of QJs.

Table 3 *QJ project characteristics and their priority.*

QJ types	Priority
QJA	Highest
QJB	High/Highest
QJC	High

4.2 Addressed quality problem

The QJC was initiated to solve a problem caused by an earlier found problem of a technical nature. The supplier delivered a component with quality issues leading to a leak. When the component broke it was replaced with a new but similar component from another supplier. However, remaining liquid in the cabling from the old component could flow back leading to a newly installed component breaking as well. In the QJB the identified problem was a cover getting loose on a supplier delivered component. The root cause was found to be a specific state of interaction between physical, chemical and software factors. The QJA was started after a number of QJC projects and QJA projects had already been performed to solve the identified quality problem. However, the multiple root causes had not been fully understood. The problem area has therefore been known widely within GTT for a number of years. The main root cause is of an almost theoretical nature.

4.3 The Quality Journal process

All QJs regarding Powertrain Engineering components follows the same eight steps of the QJ process illustrated in Figure 11. Most steps of the current QJ process have been used by QJs for years but the 7D and 8D steps were implemented more recently. The eight steps of the QJ process are described below (Volvo Group Trucks Technology 2013a).

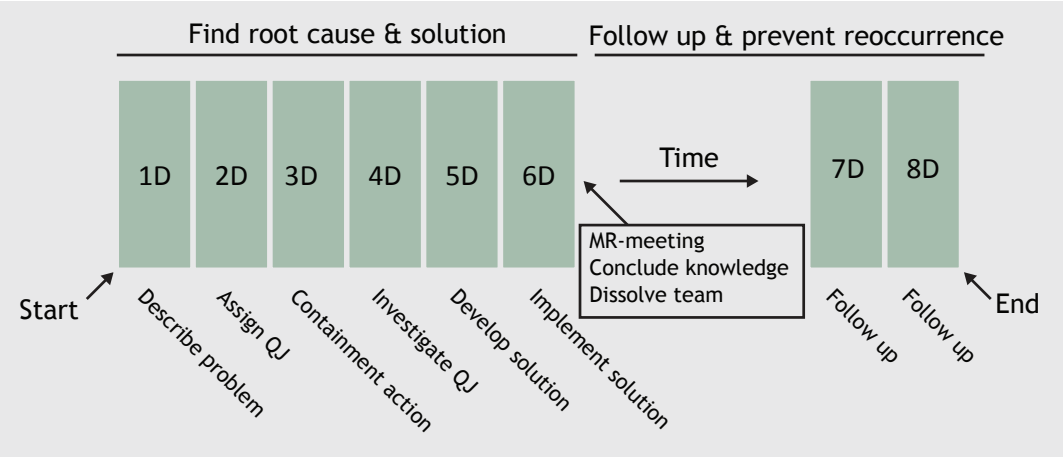

Figure 11 *The QJ process illustrated as steps with highlighted events.*

1D Describe problem - Investigate and document the problem, take a decision to open the QJ, appoint a PMQJ and a PQL.

2D Assign QJ - Define the QJ team, hold a QJ kick-off, start the investigation step with identification and verification of the root cause, check former situations, secure resources for the investigation.

3D Containment action - Decide if containment action is needed, implement the containment action and inform the market.

4D Investigate QJ - Establish the root cause, propose solution (Business Case, Impact Analysis), verify root causes and identified solutions and create an action plan.

5D Develop solution - Complete and release final development of solution including design changes, document and release production and aftermarket strategy.

6D Implement solution - Implement solution in production and in aftermarket, conduct Market Ready meeting (MR-meeting), make service instructions ready and make parts available at warehouses.

7D Follow up - Check the effectiveness of the implemented solution, e.g. by checking the fault frequency in the market after a time frame determined by the QJ team during the MR-meeting.

8D Follow up - Prevent reoccurrence (check lessons learned). The 8D step is supposed to assure that quality issues do not reoccur and the QJ is now ready to be archived.

4.4 Quality Journal team members

In a QJ, personnel from different departments participate depending on the characteristics of the identified quality issue. Some roles are however standard to gather at the QJ kick off, including personnel from: QCS, R&D, Purchasing, Aftermarket and GTO. Individuals that are part of the QJ team works for the QJ from their own department and on a daily basis usually deal with similar tasks and problems as they do in the QJ. The individuals in the QJ team also lead the QJ work within their department. Since QJs can be lengthy it is not certain that the same individuals will be part of the QJ team from start to end. The roles described in this section were part of the studied QJs. See Figure 12 for their usual involvement in QJs.

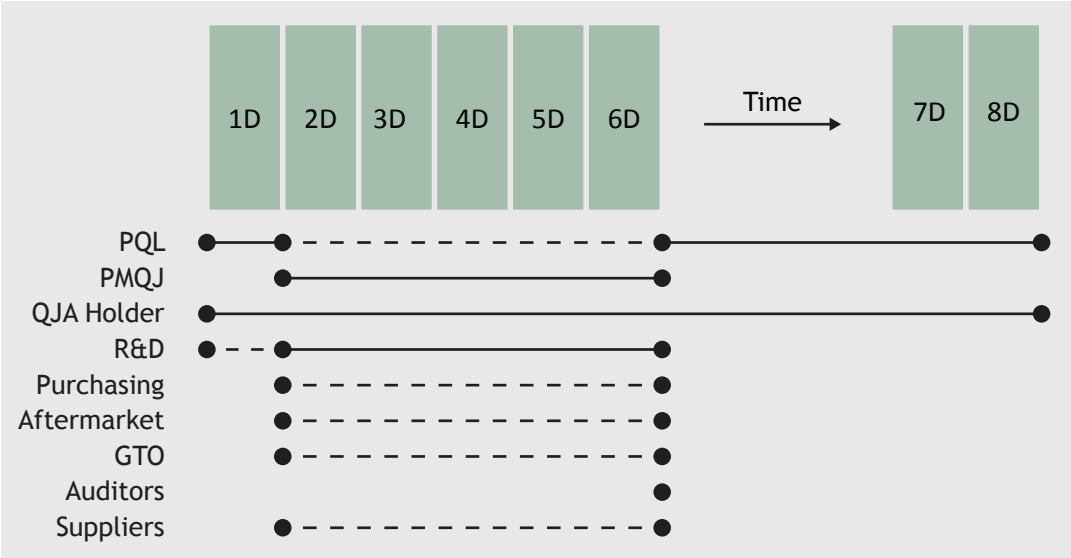

Figure 12 *The participating roles mapped against the QJ process.*

Project Quality Leader (PQL)
Before a QJ is opened a PQL working at QCS is responsible for evaluating market input, identify critical quality issues and initiate QJs. When the QJ is opened the PQL is a QJ team member but only participate in selected QJ meetings. A PMQJ leads the actual QJ work from 2D to 6D, while the PQL is monitoring the overall QJ progress. After 6D, the PQL is responsible for conducting the 7D and 8D step.

Project Manager Quality Journal (PMQJ)
The PMQJ leads the QJ work from 2D to 6D and have an overall responsibility for the QJ projects deliveries. The PMQJ has a central and important role within the QJ, organizing the team meetings and they are key for the team communication. The PMQJ also decides which specific departments should be part of the QJ team. Usually a PMQJ manage more than one QJ in parallel.

QJA Holder
In QJAs, the QJA Holder is the owner of the quality problem and has authority over all resources available for solving it. The QJA Holder is responsible for all QJA activities and is actively managing the QJA team from 1D to 8D. Compared to a PMQJ, the QJA Holder is in charge of all concerned resources and do not have to negotiate with department managers to access their personnel or other resources.

R&D personnel
Since QJs often deals with technical issues R&D most often have personnel in the QJ teams. Depending on the specific R&D department involved they will contribute with a GCR or a design engineer. The GCR decides who should participate since GCRs have the outermost responsibility for their components while design engineers are part of the GCR's team. Whoever participates, the GCR will still take part in important QJ meetings and keep up to date with the QJ progress. In the QJ, R&D personnel contribute with technical knowledge regarding the quality problem and are responsible for designing technical solutions if necessary. Usually the GCR or the design engineer is supported by their department colleagues in their QJ work even if they are the actual QJ members. In the studied QJA also a so-called engineering leader from R&D was part of the QJ team. The engineering leader was in charge of the technical efforts made to find the root cause and developing the technical solution. The engineering leader organized technical meetings regularly with personnel from involved R&D departments.

Purchasing personnel
Purchasing deals with supplier relationships, order changes and plan for introductions of new components in VGT manufacturing plants. However, purchasing personnel are more of a support function to the QJs and QCS as well as R&D personnel are more central. Purchasing individuals in QJs usually belongs to the operations part of the purchasing department.

Aftermarket personnel
Aftermarket personnel take part in QJs since they are the link to the affected customers. In QJs the Aftermarket personnel are not involved in the technical root cause analysis. Instead they take part in the QJs when appropriate.

GTO personnel
GTO personnel are regularly part of the QJ team. In QJs, GTO contributes especially with knowledge regarding manufacturing. However, in the studied QJs GTO are only involved in one QJ due to the nature of the specific quality issues and chosen solutions.

QCS and R&D Auditors
QCS and R&D auditors take part in QJs to help address and improve system and process issues. When they attend QJs, they usually only take part in the MR-meetings.

Suppliers
If a supplier has developed the component addressed in a QJ, the supplier together with R&D is supposed to analyze the technical root cause jointly. Suppliers therefore have an impact on the QJ progress and outcome. Sometimes there are differences in agendas between suppliers and VGT complicating the collaboration. It is important that the suppliers are synchronized with GTT and GTO in order to align their manufacturing with VGT's when a design change of a supplier component is needed.

4.5 Quality Journal process tool Argus
To follow the QJ process the PMQJ and PQL uses the Argus tool. Argus acts as a guide for all process steps and keeps track of requirements for passing project gates. Content must be added to Argus by the PMQJ and the PQL in order to pass the gates. This way Argus also functions as a database for storing information from the QJ. However, information used during the ongoing QJ is also stored in another online server environment accessible for the QJ team members. PMQJs and PQLs can furthermore use Argus to read about old QJ project when faced with similar quality issues.

4.6 Market Ready meeting
The MR-meeting is a cross-functional meeting ending the 6D step. Participating is the PMQJ, the QJ team and a PQL. QCS and R&D auditors are also invited and usually take part. Sometimes GCRs attends if they are not already part of the QJ team. The PQMJ is in charge of the meeting and have a checklist for what to do. Other participants share their knowledge and give input. The MR-meeting is partly a method for sharing knowledge but also a forum for assessing if the criterias to reach market ready status as well as implementing a solution have been met, e.g. confirming the root cause. Mostly technical related knowledge is discussed but also process related knowledge. During the MR-meeting a decision is made on how to evaluate the success of the implemented solution and a discussion is held in order to improve the QJ process itself, e.g. teamwork and

efficiency. These lessons learned are documented in a so called a Quality Journal White Book which is developed or presented at the meeting. Also, during the MR-meeting a discussion on how to avoid the quality problem from reoccurring also takes place and it is decided if actions should be taken to address the newly developed knowledge. MR-meetings were implemented in the QJ process during 2012.

4.7 Quality Journal White Books

The Quality Journal White Book (QJWB) is a tool for documenting lessons learned from QJs. It is used to describe positive and negative experiences about the QJ's process and result, as well as ideas for improvements. The QJWB can also contain general reflections and a summary about the quality problem. The QJWB is mostly focused on the QCS owned QJ process and little content are aimed to other departments. Input to the QJWB is accepted from anyone on the QJ team but the PMQJ are responsible for making the QJWB.

4.8 The Design Verification Guidelines database

The Design Verification Guidelines database (DVG) is GTT's KM tool. It contains information about truck components and is mostly used by R&D. The DVG is used to manage design knowledge at the Product Attribute, System and Component levels. For each component there is a file in the DVG. DVG serves to guide design engineers all along the design process of the product and facilitates to share best practice within GTT. The Global Systems Responsibles (GSR) and GCRs are responsible to create and maintain the DVG. They have to capture and analyze knowledge in order to create standard engineering guidelines. The intention of the DVG is to update it as GTT learns, so the DVG becomes a key repository for engineering knowledge. These statements are based on internal GTT documents (Volvo Group Trucks Technology, 2013b). However, the use of the DVG is different among different R&D departments and so are the amount and type of the DVG content. Different R&D departments have furthermore been using the DVG for various times.

5 Results

In this chapter the results from the data collection is presented. The main opinions and statements of the interviewees in regard to KD from the QJs are outlined. The chapter is structured according to the QJ process in the sections: General results, 1D to 5D step, 6D step, 7D to 8D step, Tools used for KD and After the Quality Journal.

5.1 General results

In this section broad themes regarding KD from QJs are presented. Results linked to QJs in general are also described.

5.1.1 Reoccurring quality issues

Some of the interviewees have experienced reoccurring quality problems from earlier QJ projects, implying that a new QJ have been initiated to solve the same problem. Two explanations are employee turnover and a not fully understood problem root causes when the QJ is ended. Another mentioned explanation is that e.g. former GCRs now part in R&D development projects do not read up on newly developed component knowledge since the former GCRs believe their old knowledge is still sufficient. During the interviews it was also stated that multiple QJs on similar issues sometimes are running simultaneously without knowing about each other. One interviewee said that in the context of a big organization it is not unusual that different people try to solve the same issues at different locations. This was the case for one of the studied QJs where the problem was being solved on the European market while it simultaneously existed in the US without the European organization of VGT knowing it. In this case, the communication issue was discovered by the component supplier, who delivered the addressed component to VGT in both Europe and the US.

5.1.2 Attitudes to Quality Journals

The general attitude towards QJs expressed among interviewees is that they truly do not want the customer to suffer from quality related issues. An experienced engineer from R&D explained that it is not positive to have a QJ on one's component. However, some components are naturally more exposed to quality issues than other. The reason may vary but it is usually possible to design a component so it can handle more than it needs to, but that will be a question about costs.

One PQL have experienced that resistance may occur when discussions about opening a QJ starts. The reason is that QJs take resources from other projects and some R&D interviewees confirmed that they do not want QJs to take too much time from their daily work. However, after launching QJs they seem to receive full priority. A PMQJ also told that the priority of QJs is clear and the attitude towards QJs conforms to the priority anchored by top management. A QJA is supposed to have top priority but one interviewee have doubts whether QJAs always gets the appropriate priority.

Regarding knowledge creation, one R&D interviewee expressed that this is done at R&D and that knowledge is not disseminated from a temporary organization like a QJ. For the interviewee the QJC, QJB and QJA was merely a status implying that "*it's work as usual, but with higher priority*". Two other interviewees agreed and one explained that a QJ is a "*forum for reporting, the real work is done outside the forum*". One R&D interviewee also claimed that there is no difference in how knowledge is handled at R&D based on the priority of the QJs. Another R&D interviewee further expressed that QJs are opened too often and ended too easily.

5.1.3 Key Performance Indicators on the Quality Journal process

In the QJ process there are Key Performance Indicators (KPIs) on lead-time between step 1D and 6D. Many interviewees expressed skepticism to this and one PMQJ argued that it is contradicting that QJs are measured on time while R&D are judged more on quality (R&D projects are however also measured on lead time). Two interviewees both stated they have had experience from QJs being closed "*just to meet the KPIs*". Other interviewees suggested that there should be more KPIs on improving the quality or solving the root cause and less on QJ lead-time. One interviewee said that KPIs focused on QJ lead-time are one of the biggest challenges in regard to KD. Regarding KPIs on step 7D and 8D, PQLs and other interviewees confirm that there are currently no KPIs for measuring KD. One PMQJ argued that preventive actions are not prioritized because there is no follow up on them for the PMQJ and another PMQJ explained that "*you only get credit when you solve the problem on time*".

5.2 Quality Journal step 1D to 5D

In this section the result reflect the first five steps of the QJ process focused on forming a team and finding a solution. The interviewees' perception of the development of solution is described.

5.2.1 Developing a solution in cross functional teams

The interviewees told that they consider VGT to be good at finding and addressing quality problems and argued that the QJs extra resources assist in doing this effectively. The early steps of QJs are described as intensive and involved individuals are available and alert. The communication is described as straight, fast and effective during the QJ. However, prior to the end of the QJ, solving the root cause is considered more important than reflecting on new learnings and KD from the QJ. The interviewees have an overall positive attitude to the constitution of the QJ teams and in both the studied QJs as well as in general, the cross functional team co-operation functions well according to interviewees. According to one interviewee, the collaboration between the different functions helps to close the knowledge gaps needed to solve the problem. However, in the studied QJA some interviewees stated that for one R&D department, with a component considered very relevant for the QJ, the participation and involvement was mostly missing. Also, even if the QJ teams are cross-functional, a big part of the QJ's work to finding the root cause and developing a solution are done by R&D members of the QJ and other personnel at the specific R&D department. This means R&D usually have a central role within the QJ and that is the case for the studied QJs as well.

5.2.2 Quality Journal team meetings

According to a number of interviewees, the frequent QJ team meetings facilitate dissemination of knowledge in a QJ. During the QJ meetings the work of each participating department is discussed as well as the progress made. The frequency of the QJ meetings depends on what step the QJ has reached. In two of the studied QJs the MR meeting was also used as a forum to decide whether or not the created knowledge was relevant to add into the DVG.

KD from QJs also occurs by informal methods. Short updates and briefings regarding QJs takes place during chats in the lunchroom and in corridors when QJ team members meet colleagues at random. In one of the studied projects, one interviewee said that KD was vastly facilitated due to the shared office space by two R&D component departments involved in the same QJ. Another interviewee expressed the difficulties to manage KD when two interdependent departments in a QJ are located on different floors in the same building. To some extent these issues are overcome by the cross functional QJ team meetings.

5.2.3 The Quality Journal process tool Argus

Regarding the QJ process tool Argus the main user is the PMQJ, but other QJ team members can also use Argus to e.g. catch up on missed QJ meetings. However, a PMQJ interviewee told that, expect from PMQJs, others do not understand how Argus works and think the tool is complex. This is confirmed by R&D interviewees that mean Argus is less user-friendly than the DVG and one of the R&D interviewees stressed the need of education for using Argus. In a QJ, all members should have access to Argus according to a PMQJ interviewee. To get access an invite is required. R&D interviewees told that they do not always have access and they also argue Argus is mainly a tool for QCS personnel and the QJ process itself. One R&D interviewee points out that access to Argus is expensive and therefore it is common for R&D members to not have access after the 6D step.

5.3 Quality Journal step 6D

In this section the results in regard to implementing the solution in the 6D step of the QJ process is described. The 6D step is the last step where the QJ team is intact and knowledge from the team progress is concluded and addressed.

5.3.1 Acknowledged knowledge to address

In the studied QJC the developed solution was addressed to R&D and Aftermarket. The knowledge obtained from the project concerned the importance of conducting failure mode and effects analyses before changing a component design. The earlier change of the design was approved to easily according to one interviewee. Other knowledge was about the need for VGT to secure that suppliers had reliable processes. The knowledge from the QJB project concerned how the problem originated and how software and hardware can be changed to avoid the problem. The knowledge was mostly connected to the design of the supplier owned component. In the QJA the team realized that previous problem solving efforts made on the same problem have had a wrong approach. The underlying problem was the same through all attempts to solve it and new design changes were necessary to grasp the real root cause in the end. This QJA has also generated a lot of spin-off knowledge, not related exclusively to the failing component.

5.3.2 Knowledge recipients

In general, the knowledge created in QJs is addressed to the departments of: R&D, Purchasing, Aftermarket, GTO and QCS. Some interviewees argued that suppliers are recipients too. The main recipient department largely depends on the characteristics of the problem and the created knowledge. In the studied QJs the interviewees consider R&D the most important knowledge recipient and the DVG was mentioned frequently as a tool for storing and reusing knowledge. To some extent knowledge usually concerns the component involved in the QJ and therefore the recipient departments are usually part of the QJ. One interviewee from Purchasing consider Purchasing's role in the QJ as secondary compared to R&Ds involvement and states that Purchasing is strongly supported by R&D. Therefore knowledge capture from a QJ is more important at R&D since the consequences of losing knowledge from a QJ at Purchasing is less critical. It was also

mentioned that Aftermarket, Purchasing and GTO commonly adjusts their work based on work at R&D. One interviewee stated that the QJ process facilitates finding a knowledge recipient since the QJ process defines who is responsible for different QJ activities. The knowledge recipient department can however sometimes be hard to find. One R&D interviewee means that when the problem and knowledge relates to multiple components functioning in a system, it is hard to identify a knowledge recipient if there is not a certain individual responsible for the whole system. Knowledge can be complex and another R&D interviewee figures that knowledge regarding R&D might be easier to address compared to knowledge regarding other departments.

5.3.3 Taking action on acknowledged knowledge

The 8D step of the QJ process supports capturing new knowledge, and it is expected that lessons are learnt from QJs. The interviewees agreed upon the need for lessons learned but how well the QJ process supports this is not clear. Some interviewees see the need for a clearly stated way of disseminating knowledge from QJs and lack a way to receive feedback on actions taken for KD. One interviewee also thinks that responsibilities for what to do and how to do the KD should be clearer for both the QJ team and the recipient departments. It is unclear if the knowledge receiving departments has supportive processes for taking care of QJ created knowledge. This is especially unclear for other departments than R&D, where a well-defined process appears to be missing. However, this does not imply that knowledge is not taken care off. A number of interviewees say that they rely on the individual responsibility of QJ team members to share their knowledge with their departments and take responsibility for capturing knowledge. Regarding the responsibility for taking action on QJ created knowledge, a PMQJ stated that if decided actions are not performed, the responsible recipient department should take the blame and PMQJs should not follow up on actions addressed in the 6D step.

Actions on acknowledge QJ created knowledge is performed during many steps of the QJs and sometimes the QJ demands DVG updates before the 8D step. PMQJs stated that it is not always necessary to wait until the 8D step to prevent reoccurrence, because if the QJ can validate the solution sufficiently during the QJ, e.g. at the MR-meeting, the DVG can be updated in the 6D step before the 7D step is executed. All interviewees that talked about the QJ enforcing a DVG update were positive. Also at the MR-meeting, content are sometimes added to the sections of Argus that should be completed in the 8D step since the content is already known.

In regard to the studied QJs the interviewees stated that design changes of components and DVG updates, in some cases, was done to preserve the created knowledge. One R&D design engineer stated that "*we don't talk about it, we build it in in our designs*". The interviewees stated that preventing reoccurrence is most often associated with updating DVG and in two of the studied QJs updating the DVG were a requirement. In the QJA, further actions was also taken e.g. developing videos explaining the problem root cause, introducing new systems for diagnostics in workshops, implementing new methods at GTO and using the new solution in ongoing R&D projects. However, R&D project gates and KPIs sometimes make new product development projects incapable of receiving knowledge from ongoing QJ. In the QJA this caused problems since the R&D development project was inflexible to adjust their project process to use the new QJ created knowledge. The QJA had created new knowledge and wanted it to be utilized as fast as possible in an ongoing R&D project. The R&D project was however not willing to use this new knowledge since it would prolong the project and have a negative impact on project KPIs. Currently there are no guidelines for how to solve conflicting like this.

Furthermore, the type of knowledge can have an impact on what actions are taken. One interviewee described two different types of knowledge content, technical related knowledge and process

technical related knowledge. The technical knowledge is addressed to the GCR of the relevant component, whereas the process technical knowledge is perceived as more difficult to manage. There are process owners to address but their processes concerns many stakeholders making this type of knowledge content more difficult to disseminate.

Another circumstance that impacts actions taken on QJ created knowledge is the size of the VGT organization. With many employees and sites in a number of countries it takes time to change something globally after a decision is made. Also, in two of the studied QJs the created knowledge was considered sensitive by VGT and therefore communications was restricted in order to avoid information leaks. Due to this fact, knowledge was not disseminated openly and some communication channels were used sparse.

5.4 Quality Journal step 7D to 8D

In this section the results in regard to the 7D and 8D steps of the QJ process, checking the solution effectiveness and prevent reoccurrence, is described. The parts reflect expectations, feedback, attitudes to KD, the interviewees' perception of KD success and responsibilities.

5.4.1 Expectations on the 7D and 8D steps

QCS interviewees, supported by others, told that the 7D and 8D steps was earlier performed poorly, but now the communication between the departments are improved and as a result knowledge is preserved to a larger extent. Also, according to QCS interviewees the 7D and 8D steps have been performed better since they became mandatory. However, the 7D and 8D steps are still regarded the weakest steps in the QJ process and how to practically prevent reoccurrence in the 8D step is not explicitly stated according to a PQL. Some of the PQLs also said that they do not know what the recipient departments do in order to preserve QJ created knowledge.

5.4.2 Feedback on addressing knowledge

After the team has dissolved in the 6D step, there is less communication between the QJ and R&D. The feedback regarding preventive actions and the solutions performance on the market is described as sparse. The PMQJs are no longer in charge of the project, and one PMQJ said that it is the PQL's responsibility to follow up the actions taken by R&D regarding preventing reoccurrence, as the PMQJs do not. However, R&D has the DVG KM tool, making it easier to follow up their preventive actions compared to actions at the other considered recipients e.g. Aftermarket or Purchasing.

Interviewees say it is up to the PQL to check whether the DVG has been updated with the QJ created knowledge or not. At R&D, the GCR gets an automatic email sent from Argus at the end of the QJ. This email contains a description of the QJ and a prompt on who to contact if no content will be added to the DVG. One R&D interviewee said that they leave no feedback on any actions they take after the MR-meeting. What content to update the DVG with or when the update will take place is not discussed with the PQL. For R&D it is a standard process to evaluate if anything should be added to the DVG after all kinds of projects. The PQLs can check if the DVG was updated themselves, but they get no standard feedback from R&D about actual updates. One PQL interviewee stated that it would be good if they did know whether the DVG had been updated, but to read the DVG themselves is not an option. For an illustration showing the feedback communication between the QJ and the R&D organization see Figure 13.

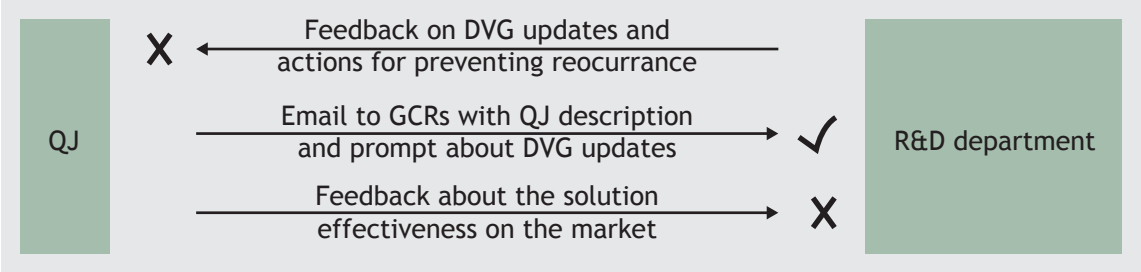

Figure 13 *The feedback communication between the QJ and the R&D organization where an x indicates that the feedback channel is not formally anchored in the process.*

Regarding the feedback about the solution from the PQL to R&D the majority of the R&D interviewees are not fully aware of how well the implemented solution actually works in the market. Some of the engineers at R&D are not even sure when the QJ project is actually finished. One common assumption from R&D is that, if they do not hear anything about the problem the solution is probably working satisfactory. Also not all R&D interviewees are interested in getting feedback from the market and R&D employees that are interested will have to ask for feedback from QCS to get any information. An exception to this way of working can however be seen in the QJA were the solution effectiveness was monitored fortnightly in a cross functional meeting after the QJ end.

5.4.3 Attitudes to Knowledge Dissemination from Quality Journals

According to the interviewees, there is a commitment at VGT to improve KM in general. However, from a number of interviews it was evident that VGT personnel have a stronger focus on problem solving than on problem prevention. The general focus of the QJ process is the first six steps and not the 7D and 8D steps. One R&D interviewee explained that "*you solve something, and understand it. When it is done, it is more like, nice we made it, but there is no real effort in keeping it* [the knowledge]". Similarly, another R&D interviewee said "*you will always get to know the problem. But for me it is more like, that was it, let's move on*". Yet another interviewee told that they feel proud when they solved a complex problem, but afterwards regardless how proud they are, KD is simply assumed to take place. One interviewee states that "*keeping knowledge is unfortunately not on top of our agenda, we could be better*". Also an R&D interviewee stated that "*from the QJ, we hear nothing about dissemination of knowledge*". Moreover, a PMQJ said that in recent years KD have been more highlighted which per se is an improvement. A PQL also told:

> *We have comments about it, but it is mostly on my side. It is my job. If we explore something new, or learn something we always try to transfer it. However, it is mostly the DVG we have in mind.*

Another PQL thinks alike and state that even if the 8D step is recognized as important, the overall focus lies elsewhere in the QJ process. R&D interviewees further explained that the perceived importance of a QJ, e.g. QJA vs. QJC, and the resources available for the QJ does neither affect the attitude to disseminate knowledge nor the effort to keep it.

5.4.4 Perceptions of successful Knowledge Dissemination

When asking if the interviewees perceived the KD to have been successful in the studied QJs almost all who answered the question thought so. Those who did not agree pointed to issues with the QJ lead-time, supplier involvement in the QJ and the collaboration with development projects at R&D. Some QJB and QJA interviewees thought that restrictions due to the sensible content might have limit the KD. Even if Argus is stated as an aid for KD, the cross functional team

meetings were regarded a better forum for KD. In one interview it was also stated that KD within affected departments are more successful than KD to other VGT sites. Throughout the interviews it was stated that there are no measurements taken to ensure KD success. Some interviewees also said that if the DVG is updated, KD is successful. In one of the studied QJs, an R&D interviewee told that knowledge was successfully disseminated but that they had no intention to update the DVG. However, there was an interest to keep the knowledge somewhere else.

5.4.5 Responsibilities during the 7D and 8D steps

The PQL is responsible for conducting the 7D and 8D steps, but in general there is a lack of understanding of what is expected of the PQL in the 8D step. One PQL interviewee explained that the responsibility is to fill in the last pieces of content in Argus, e.g. documenting the QJ process, and to end the QJ. The same interviewee considered the QCS and R&D auditors as having the overall responsible to contact process owners about improvements and to audit if any changes have been made. This statement conflicts with the ideas of another PQL who stated that the role of the PQL implies giving feedback to process owners about the conclusions from the QJ. However, this PQL also said that it is not PQL's responsibility to ensure that the targeted process is actually improved. Another interviewee from QCS also thought the auditors are responsible for making sure the quality issues do not arise again, but did not know how the auditors act.

Most of the R&D interviewees, as well as interviewees from other departments, perceived no explicit demand from the QJs to take care of the created knowledge and two PMQJs also said that they do not state such demands. However, in two of the studied QJs the criteria to update the DVG was stated before the QJ finished the 6D step. Also from the PMQJs point of view it is unclear what happens after the MR-meeting in the 6D step. One PMQJ told that they do not know for sure if agreed upon actions are performed after the 6D step.

5.5 Tools used for Knowledge Dissemination

In this section some evident activities and tools used to facilitate KD are described. The section will also reflect how they are used.

5.5.1 The MR-meeting

Regarding the MR-meetings some critique are voiced regarding unclear responsibilities for the different roles during the MR-meeting but also regarding who should take action on decisions and how actions should be evaluated. According to a QCS interviewee, the QCS and R&D auditors only take part in QJs during the MR-meetings. The R&D auditors are perceived to take part in the MR-meetings to address process related knowledge suitable for R&D. But if the auditors have not been in contact with the PMQJ before the MR-meeting they need a lot of experience to grasp the complexity of the problem according to the same interviewee.

Furthermore, one PMQJ interviewee stated that the biggest challenge in regard to KD from QJs is to ensure that what is decided during the MR-meetings is enforced. One PQL interviewee also pointed out that since the true effect of the solution have not yet been verified in the market at the time for the MR-meeting, there is a potential risk for addressing knowledge wrongly if the solution later is concluded to not solve the true root cause.

5.5.2 The QJ White Book

Regarding how the QJWB should be used, the ideas seem to differ between the interviewees. While a QCS interviewee said that the QJWB can be used to share knowledge to the rest of the VGT, an R&D interviewee said that the QJWB is not a tool for keeping knowledge about technical

learnings e.g. the best component design. One R&D interviewee argued that the QJWB is good for QJs but not good in regard to knowledge about components. Another R&D interviewee stated that the QJWB should answer "*what went wrong, what was good and what can we do better*". Also, it is clear that the QJWB is a PMQJ deliverable but it is unknown, at least for the PQLs, if a QJWB have to be written for every QJ. Currently a QJWB is not made for all QJs but Argus is on the other hand always filled in.

As stated during one interview, the QJWB in the studied QJC, presented at the MR-meeting, was fitted in two PowerPoint slides with content regarding the QJ progress and the identified root cause. Regarding the amount of content in a QJWB one R&D interviewee said that during the MR meeting only the most important topics of the QJWB are presented and what is saved in the QJWB should be all project learning's and certainly more than two slides of a presentation. However, another interviewee told that it is good that the QJWB is not a large document and historically the QJWB have not focused on the root cause. One PQL interviewee also stated that there is a bit of a double work since what is in the QJWB also needs to be written and stored in Argus.

5.5.3 The Design and Verification Guidelines database

As a central KM tool at VGT and the as the most mentioned KM tool during the interviews, understanding the DVG is important. The results about the DVG are divided into four parts in this section describing the perceived purpose, its content, how content is added and responsibility for reusing knowledge.

5.5.3.1 Perceived purpose of the DVG

Many of the interviewees talked about the DVG when asked about methods and tools for KD. The interviewees told that the DVG is a system for saving knowledge and learnings that could be valuable for the VGT to remember in the future, regardless of the knowledge source. The interviewees also stated that it could be of great value to be able to look at historical learnings when faced with new projects. The goal with the DVG is perceived by the interviewees to give an overview and a moderate understanding of the specific component and experienced problems. One GCR interviewee said the DVG purpose is to prevent reoccurrence of quality problems and that the content of the DVG could also apply in other contexts in new development projects. Other interviewees have said that the purpose of the DVG is to make QJ created knowledge available for reuse, to keep knowledge otherwise lost due to the personnel turnover. They argued that GCRs normally hold their particular position for two to three years. One interviewee stated that the purpose of the DVG is to facilitate communications between global VGT sites by providing an understanding of experienced faults and counter actions. Since solely one individual are linked to each component in the DVG, the DVG is also explained as an aid for connecting people. The interviewees also said that the expected reader is not mainly the GCR for the component but rather design engineers developing other components.

5.5.3.2 Content of the DVG

When R&D started to use the DVG it contained general information about how different components worked. Nowadays, the DVG contains technical related knowledge about the component, but also previous problems experienced. For example, critical problems leading to QJs should be described. However, there is a trade off regarding how much detailed content the DVG should contain. One interviewee said that if the DVG would describe every single problem experienced with the component no one would ever read the DVG and it would be difficult to grasp everything. One interviewee told that people have different opinions about what to write in the DVG. The same interviewee did copy and paste content from Argus into the DVG but got feedback from the GCR's manager that this practice was not good enough since it did not cover how the problem could be

avoided in the future. In one of the studied QJs, a GCR manager also took over the authority to update the DVG from GCRs to ensure a balanced level of details. One interviewee also stated that the template in the DVG for how to add content is not working for components developed by suppliers. The interviewee would therefore like to have one template for GTT developed components and one for supplier developed components. Another R&D interviewee stated that certain content is not added to the DVG as some content needs to be kept internally only for some VGT employees and it is unknown who have access to the DVG.

5.5.3.3 DVG updates

In the interviews a number of reasons for updating or not updating the DVG have been stated. One reason according to R&D interviewees is the need to validate the implemented solution before updating the DVG. The DVG can at its earliest be updated after the MR-meeting in the 6D step, because at that time the solution has been verified internally. However, it is more common that the DVG update is done up to a year after the implementation of the solution, since R&D want to know that solution works on the market. R&D departments are usually happy to update the DVG but they are under heavy workload and postponing an update could increase the risk to forget to do it. One R&D interviewee said that if the DVG is not updated directly after the MR-meeting it will be forgotten since it is not of high priority. There are no standard processes or tools available for GCRs to remember the issue and the knowledge until the solution is verified on the market. In regard to the time until a DVG update, one interviewee stated that if many individuals know about the problem and the solution it is less of an issue. However, another interviewee stated that if the problem and solution is widespread it might have a negative effect on updating the DVG, while yet another interviewee say this have no affect since personnel usually change positions within three years. However one R&D interviewee have another mindset about keeping knowledge from previous quality issues and stated that design engineers always face new challenges and therefore old problems are left behind while new problems occur due to the continuous development.

If the problem root cause merely has an indirect impact on a component the DVG is usually not updated, according to some of the R&D interviewees. Furthermore, one R&D interviewee explained that the DVG have many irritating errors e.g. access problems and deleted content. The R&D interviewee means the idea with the DVG is very good but it is not user friendly in its current state and this gives the user a negative attitude to the DVG. The management support is also important for the routines of DVG updates. Interviewees argued that the management has great influence over what to do and when to do it. However, one R&D interviewee stated that the management have not communicated that the knowledge capture is important. A GCR told that sometimes there is a lack of resources for updating the DVG and if it is not a QJ requirement it is more likely that other things get prioritized. Also another interviewee has concerns with management prioritizations and told that the current strategic objectives will decrease the time for working with the DVG substantially. One interviewee said that "*it is important to have resources spared for lessons learned*" and a GCR interviewee agrees.

Furthermore, other interviewees told that the work with updating the DVG is not as structured as it should be. Even if this work should be done continuously throughout the year, time is usually no put aside for updating the DVG at R&D. Interviewees stated that the DVG is updated randomly now and then, when somebody brings the issue up or during a certain time every year. During the fall of 2013 the management decided to focus two full days explicitly on updating the DVG for all relevant Powertrain Engineering personnel. All other work was set aside and during these two days, a lot of new content was added on different components in the DVG according to the interviewees. One interviewee said that if it had not been for the specific DVG days, some content might not have been added to the DVG at all. From the interviews it is clear that if a DVG update is requested during a QJ it is more likely that the DVG really gets updated.

5.5.4 Responsibility for reusing Quality Journal created knowledge

One interviewee stated that it is an R&D responsibility to make sure knowledge is captured and reused. Others have said that when a GCR take part in a QJ team the GCR will have the responsibility to update the DVG, if that is a QJ requirement. If a design engineer takes part in the QJ instead of a GCR, that individual will get the responsibility from the QJ. In this case the design engineer have the responsibility in the QJ but it is still the GCR that have the authority over if and how to update the DVG.

Usually the QJ team tries to decide who should be responsible for updating the DVG during the MR-meeting but this is sometimes unclear anyway. This problem can arise when different components are affected by the root cause or when the solution is a design change to a fully functional part. In the QJC the QJ team did not require a DVG update but R&D interviewees stated that they wanted to keep relevant knowledge in the DVG for future projects regardless of the QJ team's standpoint, as updating the DVG is part of other R&D processes.

5.6 After the Quality Journal

This section describes the results from the collected data in regard to KD taking place after QJs end in the 8D step.

5.6.1 Knowledge stored in individuals

Regarding what happens after a QJ the interviewees agrees on that knowledge is mostly kept in individuals. A whole lot of the experiences from the QJs never reach a document. One R&D interviewee said that "*in our documents, we don't specify the problems, but we update our specifications with additional data that secure certain functions*". Another interviewee said "*preferably, you want to keep the skilled engineers. To keep knowledge in the group is difficult. The component is continuously developed*". This interviewee was concerned with what happens when a component is developed without historical knowledge and argued that competence is crucial to the success of new designs. Another interviewee is certain that the individuals involved in QJs have more knowledge, than individuals not actively taking part.

One interviewee thought that the work with preventing reoccurrence of quality problems could be more systematic, but that would be a management decision. Furthermore, an R&D interviewee told that it takes about one year to get to know one's specific component but when you have more skills you will also understand how the component interacts in a system. One interviewee stated that if component knowledge cannot be kept by the R&D group working with the specific component is can be secured by the overall system owner.

5.6.2 Reusing knowledge created in Quality Journals

The R&D interviewees stated that there is no requirement or structure for when to read the DVG. They also say that there is no time available to read the DVG unless if you are looking for some specific information. But in that case, the DVG is a good starting point. However, in the interviews it is explained that R&D personnel with new positions have more time to read the DVG in the beginning of their employment and all interviewees agree that the content in the DVG is particularly good for a new engineers. As one interviewee explains, the GCRs knows what has been going on with their components for as long as they have been GCRs but when these individuals quit the successor GCRs needs to acquire the same information in some way. Some interviewed GCRs said they use the DVG themselves regardless of their experience while one design engineer states that he have never used the DVG since this is a tool for GCR managers. Another R&D interviewee stated that he reads the DVG at the absolute maximum once per year and for him it does not matter if the DVG is updated or not.

Most interviewees also said that engineers working on one component also read the DVG for components other than their own. It is explained that everyone should be able to read the DVG for a component to get a better understanding. For example, QCS personnel can access the DVG and at least one PMQJ do read about the QJ specific component before starting the QJ work. One interviewee stated that it is important that the DVG content is updated and one R&D interviewee explains that in fact the final recipient of DVG content should be R&D development projects where the component is part of the project. However, R&D interviewees do not know if anyone else has been reading about their own component in the DVG. One R&D interviewee thinks few persons reads the his DVG, but the R&D interviewee does not read about others' components and thinks GCRs in general only read about their own component when they have to update their own DVG content.

5.6.3 Effectiveness of the DVG

In regard to the usefulness and effectiveness of the DVG for KM the interviewees stated that they do not know if the DVG have had any effect and one interviewee say the DVG effectiveness is not measured. At the same time, one of these interviewees said that the DVG "*gave me as a newly employed a better insight and understanding of other components*". Another R&D interviewee stated that there is no effect of the DVG, and points out that they started working with quality issues in the DVG during 2013. Other R&D interviewees said that the DVG currently is being developed and there are different amounts of content on different components. A QCS interviewee also stated that working with the DVG seemed a bit new to some R&D departments since sometimes QJ members from R&D do not seem to understand that they can find information in the DVG. On the other hand, one R&D interviewee said that the QJs are good at using the DVG for KD. One interviewee told that a big challenge is that it is hard to get KD to work with ease, and that it is hard to get knowledge into a system that will be useful for everyone since "*... the conclusions you can make based on your experience is hard to write down on paper*".

5.6.4 Reusing content from Quality Journal White Books

The majority of the interviewees recognize the QJ team members as the main readers of the QJWB. The PMQJs are identified as the recipients for project feedback and many interviewees also believe that the PMQJ have the skill to find QJWBs and read them. An R&D interviewee stated that the individuals responsible for improving the QJ process are the recipients of the knowledge content from QJWBs. A PQL interviewee points out that QCS managers, responsible for PMQJs and PQLs, should be interested in the QJWB content. Future QJs are also recipients for QJWB lessons learned accordingly to some interviewees. A typical example is when a QJ is reopened and there is a need to understand why the last QJ did not succeed. However, a number of interviewees clearly doubt that the QJWBs are read at all nor that they are used in other projects. They stated that the QJWBs with their knowledge and learnings are just stored somewhere and therefore not of any use. One interviewee explained that if the QJWB does not have a recipient, knowledge would merely be kept by the individuals that were part of the QJ.

6 Analysis

In this chapter collected data on four different areas of KM are related to the QJ process and analyzed. The areas are knowledge creation, knowledge capture, KD and knowledge reuse. The analysis is focused on KD and the KD is analyzed in both a short and long time perspective to decompose the analytical findings. KD in the short time perspective regards to KD during the QJ in step 6D to 8D. The long time perspective describes KD after the QJ ends in step 8D. Figure 14 illustrates the decomposition. The research framework is used to sort influencing factors into the categories: Actors, Source, Recipient, Content, Media, Activity and Context. Each factor is mainly analyzed separately even though many factors interact and have a combined effect on KD within VGT. Relevant KD recipients are also defined and described.

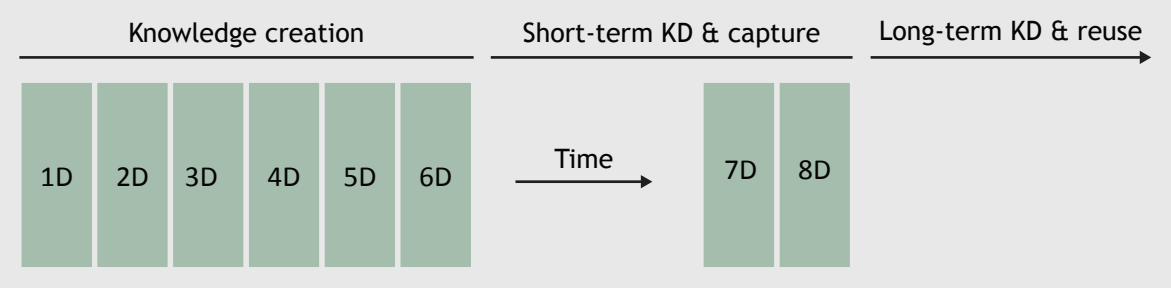

Figure 14 *Analysis of KD related to the QJ process.*

6.1 Knowledge creation

In this section the knowledge creation process in the studied QJs is analyzed. This correlates to step 1D to 5D of the QJ process. In all studied QJs new knowledge have been created. There is knowledge about the root cause, about how the issue emerged and what the symptoms are. Further, there is also knowledge about the implemented solution and how it works in the market. At last, the experience of the QJ results in knowledge about how the actual work in the QJ was performed e.g. what went well and what could have been done better.

Since QJs are launched after a quality issues emerge in the market, there are customers suffering requiring quick actions from VGT in order to mitigate negative effects. This environment of emergency leads to quick decisions and lack of time for validation, which might have implications for the quality of the created solution. According to the interviewees the problem is however in most cases understood and solved with success. Clearly stated enablers are the cross-functional collaboration and having relevant resources available to solve the quality problem. Within a QJ it is clear that knowledge is created continuously and the cross-functional involvement also makes knowledge disseminate continuously between individuals as well as different departments. Nonaka (1994, p.24) acknowledge that:

In sum, the cross-functional team in which experience sharing and continuous dialogue are facilitated by the management of interaction rhythms serves as the basic building block for structuring the organization knowledge creation process.

In the 6D step the QJ created knowledge is regarded as concluded, even if the success of the solution in the market has not been evaluated yet. Despite the fact that the QJ teams seem to be successful in developing solutions for quality issues emerging in the market, the interviews have concerns for what happens with the QJ created knowledge after the solution is implemented in the 6D step. Also, there is some evident confusion about when the QJ process is actually finished. Many interviewees generally describe that the QJ ends in the 6D step when the solution is implemented and the QJ team is dissolved. However, some interviewees and internal VGT documents states that the QJ process really ends after the 8D step.

For quality problems there are sometimes multiple root causes present. A QJ does however not usually address all root causes simultaneously. What root causes to prioritize can be based on the expected effect, the business case and/or the project timeframe. Decisions on priorities will most likely affect what knowledge is created. In regard to the studied QJA, previous QJs had been going on for years when the QJA was initiated to solve the same problem. Earlier QJs did not solve the true problem root cause, which explains the reoccurrence of the QJs. Regarding knowledge creation, a lot of knowledge was generated in the previous QJs. This knowledge was later useful pieces for the progress of the studied QJA. Clearly, even failing QJs can contribute to increase VGTs knowledge and be useful later on. However, the previous failures prolonged the project and it took more of an effort to convince upper management to agree on the proposed solution.

6.2 Short-term Knowledge Dissemination and capture

This section aims to analyze factors affecting KD after the knowledge creation takes place in a QJ. The focus is a short-term perspective. Short-term relates to the 6D to 8D steps of the QJ process. The analysis is structure based on the research framework and the identified factors for this KD are sorted according to the research framework elements, see Figure 15.

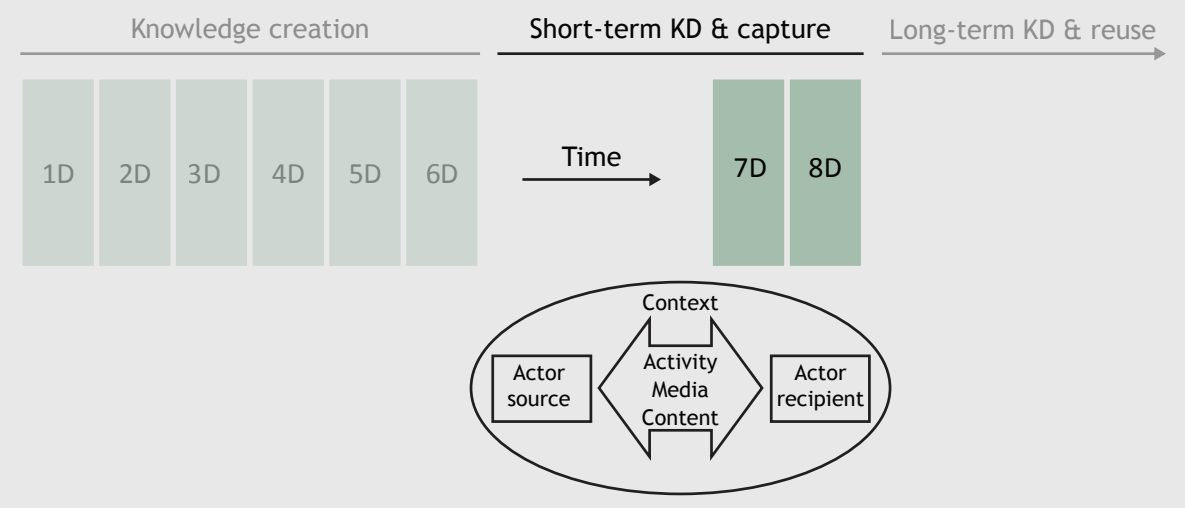

Figure 15 *The short-term KD related to the research framework and the QJ process.*

The dissemination of the QJ created and concluded knowledge starts in the 6D step, e.g. during the MR-meeting. The solution is then evaluated in the market during the 7D step and KD about

the solution success in the market can take place. In the 8D step the QJ team should know if the recipient department received the knowledge properly, to be able to verify that sufficient actions have been taken to prevent reoccurrence.

6.2.1 Identifying the knowledge recipient

From the interviews it is evident that a number of groups and departments at VGT are potential recipients of QJ created knowledge. However, for several reasons the R&D organization is the acknowledged recipient in this analysis. Firstly, R&D are pointed out as the main recipient by a majority of the interviewees as they consider R&D to be the department that have the biggest possibility to take action on the knowledge and solve the quality issue for the future. R&D as a recipient is also acknowledged by Nonaka and Takeuchi (1995) who e.g. argue that utilizing knowledge when developing new technologies and products was a key behind the success of Japanese companies. Secondly, R&Ds decisions commonly affect other departments, e.g. changing the design of a component usually leads to a change in specification for purchasing, a change in instructions at GTO and a change of spare parts handled by Aftermarket. Thirdly, compared other non QCS involved departments in the QJs, R&D always have represents in the team from 2D to the 6D step. This makes them a likely recipient. Lastly, the R&D organization is by interviewees recognized as the only studied internal organization that has a tool comparable to a knowledge bank, the DVG, in which knowledge created by QJs can be capitalized.

6.2.2 Successful Knowledge Dissemination

Some authors, e.g. Davenport and Prusak (2000), suggest that successful KD should result in an action taken by the recipient. This definition, in the short-term KD, is mostly associated with two possible actions. The first is design changes by R&D to solve the quality issue. The second is actions taken to capture the knowledge and create conditions for reuse of it. This is mainly associated with updating content in the DVG. Several interviewees also expressed that a DVG update would imply KD success. No evident issues regarding KD from QJs to the R&D organization have been found, probably since R&D individuals are always part of the QJ team and they also involve others from their specific R&D department in the QJ work. On an individual level it is usually the same R&D individuals both sending and being part of the specific R&D department receiving QJ created knowledge in the short-term time frame.

6.2.3 Influencing factors

In this section identified factors influencing short-term KD are described and categorized according to the research framework.

6.2.3.1 Actors - source & recipient

Knowledge distance

The factor knowledge distance refers to the degree the source and the recipient has similar knowledge (Cummings & Teng 2003). In this study the QJ and the R&D organization has a similar knowledge base since R&D employees with expertise are involved in the QJ. The knowledge distance between the two actors can therefore be considered small. The knowledge distance factor is profoundly supported by various authors, e.g. Duan et al. (2010), Cummings and Teng (2006), Cummings and Teng (2003) and Paulin (2013).

Trust

The receiving departments declare that they most often have full trust in official information from the QJ team. Trust is also frequently mentioned as a crucial factor affecting KD in the studied literature, e.g. Paulin (2013), Duan et al. (2010) and Reige (2005). According to Goh (2002) trust

is fundamental in all co-operations on a group level and Davenport and Prusak (2000) argue that all knowledge initiatives will fail without sufficient trust.

Attitude to Knowledge Management
Through the whole study it has been evident that VGT personnel care about KM and they understand that there is potential to improve KM at VGT. Some employees have taken initiatives on their own to ensure successful KD in the studied QJs. This attitude to KM is a factor having a positive effect on the KD and Cummings and Teng (2003, p.48) writes that:

> *The need for a culture of learning in an organization to facilitate organizational learning in general, and knowledge transfer specifically, has been emphasized by many researchers.*

Cabrera et al. (2006) furthermore includes coworker support among the factors that have positive influence on the willingness to disseminate knowledge.

6.2.3.2 Actors - source

Clarity of responsibilities
A factor affecting the KD is the clarity of responsibilities in the QJ team. On the individual level it is not clear which role is responsible for ensuring the KD from QJs to R&D. The PMQJ is responsible for the QJ's 6D step including the MR-meeting, the PQL is responsible for the 8D step about preventing reoccurrence, and the R&D team member is the obvious link between the two actors. The R&D member is also the recipient usually benefiting from the created knowledge directly. An error can emerge if the PMQJ or PQL believes the R&D member will ensure KD while the R&D member believes that the PMQJ or PQL take responsibility as project managers. For example it is not clear from the interviews who is the outmost responsible for makings sure knowledge is added to the DVG. This potential error might be the reason for why updating the DVG is a closing criterion in some QJs and not in others. Furthermore, sometimes responsibilities seem to be clear but what those responsibilities actually imply is more diffuse. For example, it is widely known that PQLs are responsible for the 7D and 8D step but the expectations are unclear. For example it is not made clear if the PQLs should merely fill in content in the 8D section of Argus in the 8D step or if the PQLs should take other actions to prevent reoccurrence. Also, there seem to be some unclarity of what can actually be expected from both the QCS and R&D auditors when they take part in the MR-meetings. This is the case even though they are recognized as responsible for addressing process technical knowledge.

Sense of importance
In the QJ team a positive factor for KD is the sense of importance of the created knowledge. The created knowledge from the QJ is important since it will have an affect on e.g. the company costs and future product quality. The more important the knowledge is, the more motivated the QJ team is to disseminate it. Motivation is identified by e.g. Duan et al. (2010) and Szulanski (1996) as a key factor for KD success. Knowledge from a prioritized QJ, e.g. a QJA, should therefore be disseminated to a larger extent than knowledge from a QJ with lower priority, e.g. a QJC. This seems to be true for the studied QJs. For example in the QJB, the DVG was updated while it was not in QJC. In the studied QJA the team made DVG updates a closing criteria but also e.g. produced videos to facilitate KD. The sense of importance factor can be compared with Cummings and Teng's (2006) KD variable strategic intent, originally from Arrow (1971), about the source's intention to complete the dissemination. Sufficient resources are however a prerequisite for KD and in QJA there are more resources available, for general purposes but also for preventing reoccurrence, than in a QJB or QJC. Cummings & Teng (2003) mentions importance as a factor

and they use the notion project priority. However, in their research this factor did not have any significant implication on KD.

6.2.3.3 Actors - Recipient

Sense of importance
In contrast to the QJ team, the recipient R&D departments take lightly on what the QJ teams consider to be important knowledge. The factor sense of importance have an impact on the R&D organization and on how knowledge are captured but they will decide what is important knowledge themselves since QJs are only one source of knowledge about R&D components. From the R&D interviewees it was not stated if QJA or QJB created knowledge is more likely to be captured and accepted than any other knowledge. In extreme situations this could probably lead to severe organizational problems if one part of the organization does not acknowledge what another part of the organization think is critical. However regarding the studied QJs, content was added to the DVG during both the QJA and QJB.

Available resources
Available resources are identified as influencing factor from the interviews. Updating the DVG is time consuming, and there is only one individual in each studied project with authority to make changes in the DVG for respective component. This implies that the DVG is not updated on a regular basis. The DVG mostly gets updated when management push for it to happen, when management provide time for it or when the QJ demands it as an end criteria. Resources are an influencing factor in the literature as well. Riege (2007) states that adequate resources should be allocated for undertaking tasks for which individuals are given responsibility. This is also supported by Goh (2002) and O'Dell and Grayson (1998), who emphasize the importance of providing time for knowledge activities. Furthermore, even if QJs would always demand DVG updates it is not sure it would counteract the factor of available resources. This is especially true if the QJ push for a DVG update in the 6D step because at this stage of the QJ process the solution have not been validated in the market. Therefore, there is a risk that the implemented solution does not get full support. Referring to Nonaka's (1994) definition of knowledge as "*justified true belief*", it is possible to question the value of knowledge in the 6D step since the solution is not yet fully justified.

Not-Invented-Here syndrome
Cummings and Teng (2003, p.49) write that:

> *In some organizations, the not-invented-here syndrome can prevent recipients from accepting outside knowledge…, especially if doing so requires its members to abandon knowledge and abilities that have been important to them personally.*

Furthermore, Michailova and Husted (2003) state the Not-Invented-Here syndrome as one of three obstacles originating from individual behavior. One example of this factor was seen during the interviews in regard to the QJA. One specific R&D department showed little involvement in the QJA even though their component was heavily affected by the problem. This made other QJ team members skeptical to how much knowledge that department had captured from the QJ. Furthermore, one interviewee from the stated department expressed skepticism to the success of the QJ implemented solution in heavy contrast to the other QJ team members' belief in the solution.

Timing between knowledge validation and knowledge capture
After the QJ solution is implemented is can take up to a year before the solution is validated. This

leads to confusion about when to take action to capitalize knowledge. Taking action early, e.g. in the 6D step, the solution it is only validated internally at VGT and there is a risk that the solution is not fully supported. Insufficient evaluation has been identified by Reige (2005) as a barrier for KD. Furthermore e.g. the DVG might need to be corrected at a later stage based on the later market validation. On the other hand, taking action later, e.g. in the 8D step, increases the risk of forgetting the knowledge and to take an action. The QJ process in itself enhances this confusion since the interviewees perceive that there are two QJ ends, one in 6D where the team splits up and project learnings are discussed, and one in the 8D step after getting the market response.

6.2.3.4 Media

Involvement
The more involvement in a KD process, from both source and recipient, the higher probability of successful KD according to Cummings and Teng (2003). Especially relied on for KD are QJ members from R&D. It is not unexpected that their role is important for the KD since the R&D members is both part of the QJ team and simultaneously part of the recipient R&D organization. Choosing appropriate media is also important for KD success according to Duan (2010) and for the short-term KD between QJs and R&D, most knowledge is disseminated through QJ meetings, R&D members, the MR-meeting and via informal encounters between employees. All these tools for KD encourage personal involvement from QJ team members. In the short-term perspective this is also a successful approach because face-to-face communication is richer and less obstructed than communication via more codified media (Pedersen et al. 2003).

6.2.3.5 Activity

Frequency
The frequency of the communication between the QJ and the R&D organization seem to decrease after the 6D step. This is mainly because the QJ team splits up after the MR-meeting and the team-members returns to their daily work. This factor implicates the important two-way communication, which becomes sparse. Cummings and Teng (2003) have also found a correlation between the number of transfer activities and KD. In accordance Reige (2005) who also mention that insufficient communication is a barrier for KD.

Feedback on action for knowledge capture
The feedback on actions for knowledge capture is a factor that affects KD between QJs and R&D. The pattern for communications change after the 6D step and the two-way communication is not as reciprocal as earlier. This impacts the KD and consequently its effectiveness. Reige (2005) states insufficient feedback is a barrier for KD. In QJs the PQL is responsible for the work in step 7D and 8D. The PQL checks the valuation of the implemented solution in the market but does not give any formal feedback to R&D on how the solution do compared to the expected failure frequency, at least not if the failure frequency is acceptable. On the other hand, R&D does not request feedback and from the interviews it shows that R&D assumes that the solution works, if they do not hear anything else. Furthermore, it is not clear what kind of feedback R&D gives to the PQL regarding performed DVG updates. Whether this feedback is necessary is hard to judge but the PQL is responsible for the 8D step and it would be logical if the PQL did know about all preventive actions. At QCS the PMQJs pay little attention to the 7D and 8D steps of QJs as their role has little interest in the solution success or preventive actions taken. They have no special interest of feedback regarding the knowledge capture.

6.2.3.6 Content

Addressability of knowledge content
The characteristics of the created knowledge in QJs have an impact on the KD. The interviews suggest that knowledge about a system of components compared to knowledge about a single component is harder to address. This is e.g. knowledge explaining how the components interact if one component fails. For the source it is hard to find someone responsible for the specific system of components identified. It is also hard for a single GCR owning one of the components in the system to capture the system knowledge since the system knowledge is not fully applicable to the GCR's component. It is however not fully applicable to any other GCRs' component either. Based on the interviews, it seems that the DVG is structured around single components, which makes it hard to store system knowledge within the DVG. There is consequently a risk that no one will take on responsibility for overall system knowledge that does not regard a specific component. During MR-meetings both technical and process technical related knowledge are discussed. However, process technical related knowledge appears to be more difficult to address. Duan (2010, p.360) means that "*...organizations should have clear objectives and should focus on what, and how, knowledge can be transferred*".

Sensitivity of knowledge content
Another factor regarding the knowledge content is its sensitivity. The more sensitive the content is for VGT, if it would end up in the wrong hands, the less it will be shared internally. An example is content that might have a negative impact on VGT's reputation if made public. Therefore, in a QJ with this type of knowledge content the KD will be less detailed than optimal for KM purposes. This is true whether the media used is verbal or written. Clearly sensitive content might affect the openness for KD and Duan et al. (2010) provide evidence for openness as a factor.

6.2.3.7 Context

Evaluation of the Knowledge Dissemination process
To continuously improve the QJ process the QJWB is used. However, the QJWB cannot be used to improve the 7D and 8D steps since the QJWB is concluded in the 6D step during the MR-meeting. No other structured tool for evaluating or improving the 7D and 8D steps has been described in the interviews. Also Reige (2005) finds insufficient evaluation to be a barrier for KD.

Key Performance Indicators on Knowledge Dissemination
The interviews support that the QJ process is evaluated with different KPIs with the main KPI being QJ lead-time from step 1D to 6D. There are however no KPIs on the 7D and 8D steps of the QJ process and there are no other KPIs on KD. The heavy focus on problem solving has a negative impact on the efforts made in regard to KD activities, which are given little support. It is clear that reactive quality improvements are rewarded and proactive actions like KD activities are not. The heavy focus on QJ lead-time has also been acknowledged by a prior study at VGT. This study was performed by Boberg et al. (2012), from the Southwest Research Institute, and focused on the QJ problem solving processes. Data was collected from VGT sites in Hagerstown and Gothenburg. Duan et al. (2010) identified the need to have a common objective for the KD. Reige (2007) further states that the leadership and managerial direction in terms of clearly communicating the benefits and values of KD practices are factors. Jang-Hwan et al. (2006) show that top management support affects employee commitment and through that commitment affect both level and quality of the KD. Cabrera et al. (2006) includes perceived supervision from top management as a factor with positive influence on the willingness to disseminate knowledge.

Balance of the Knowledge Dissemination process

The allocation of the QJ process responsibility between PMQJs and the PQLs is another factor. The PMQJs are responsible until the QJ created knowledge is concluded in the 6D step. The PQLs are then responsible for the 7D and 8D step where the relevance of the previously concluded knowledge are reevaluated, e.g. based on the market valuation, and the prevention of reoccurrence of quality problems should be ensured. The PQLs does not have the same insight in the QJs as the PMQJs but should still months after the QJ teams dissolve manage this process themselves. Boberg et al. (2012, p.11) also acknowledge this unbalance and states that "*maintaining engineering and quality resource continuity for the final 8D steps would result in a better overall outcome to the problem solving effort*". Ward et al. (2007) acknowledges a hand-off to result in a "*knowledge waste*", where a hand-off is when the knowledge, responsibility, action and feedback are separated.

6.3 Long-term Knowledge Dissemination and reuse

In this section, KD is analyzed with respect to a longer perspective than in the previous section. It is assumed that R&D has already captured knowledge from a recent QJ and this analysis mainly focus on how this knowledge is reused at R&D. Reuse of knowledge at R&D can be viewed as KD from the current R&D to the R&D organization of tomorrow. It is still the same department but there is a new set of individuals forming the department. Figure 16 illustrates the long-term KD, the research framework and the QJ process.

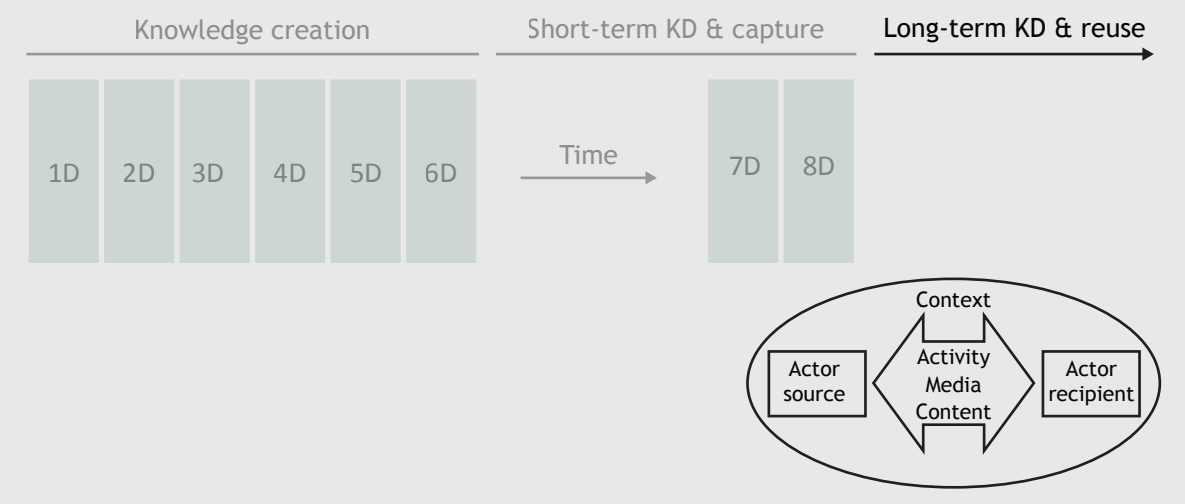

Figure 16 *The long-term KD related to the research framework and the QJ process.*

6.3.1 Identifying the knowledge recipient

As in the short-term KD section, the acknowledge knowledge recipient is the R&D organization in the long-term perspective as well. However, in regard to the studied QJs it has not been possible to collect data from individuals being long-term knowledge recipients at the R&D organization. The studied QJs are simply not old enough to make it possible to study how knowledge from them has been reused in a long-term perspective. Interviewees from the studied QJs have however been able to talk about the long-term KD in general terms based on their previous experiences from other QJs.

6.3.2 Successful Knowledge Dissemination

As in the short-term perspective, KD is considered successful if the recipient has taken a corresponding action. In the long-term perspective an action should therefore be taken on prior

created knowledge, e.g. from an old QJ, that have been stored at R&D. This reuse of knowledge could e.g. be to use contents from the DVG in R&D development projects. Due to the actually timeliness of the studied QJs it has not been possible to assess if the long-term KD have been successful in this study.

6.3.3 Influencing factors

In this section identified factors influencing long-term KD are described and categorized according to the research framework.

6.3.3.1 Actors - source & recipient

Knowledge distance

In the long-term perspective the knowledge distance is assumed to be small. The source, the current R&D organization, and the recipient, the next group of engineers at the same R&D department reusing knowledge, are believed to have very similar competencies. It is the same departments doing the same type of work while the components and the methods develop over time.

Trust

It is reasonable to assume that a department at R&D has trust in what predecessor engineers try to communicate. Some interviewees have questioned if technical component knowledge will be relevant in the future since the components changes continuously. However, this is about the perceived usefulness of the knowledge rather than having trust in the source.

6.3.3.2 Actors - Source

Clarity of responsibilities

At R&D the responsibility for who should add knowledge to the DVG is clear. GCRs are responsible for adding knowledge about their components and assessing the quality of the DVG content. Adding QJ knowledge to the DVG is only one of many ways to disseminate knowledge for future reuse at the R&D organization, but the DVG is regarded the main tool for KM and KD at R&D.

Available resources

This factor plays out for R&D as the short-term recipient but also for R&D as a long-term source. R&D as a source needs management support together with sufficient resources. Without available time and clear guidelines for when to add content to the DVG, updates will not be done since other work is usually more urgent. GCRs do not see the benefit of updating their own DVG in their daily work and will therefore not prioritize to update the DVG to maybe benefit from it in the future. If the GCRs believe they are not the intended user the motivation to update the DVG will probably be even lower. Currently, content in the DVG is updated rarely and usually once a year. The only example from the interviews when management recently assigned specific resources for DVG updates was for two days during the fall of 2013. Reige (2005) states a factor to be deficiency of company resources that would provide adequate sharing opportunities, Reige (2007) points out that a lack of time to disseminate knowledge and an intrusive KD activity leading to extra work are also barriers.

6.3.3.3 Actors - Recipient

Clarity of responsibilities

The responsibilities at R&D for reusing knowledge seem to be clear, at least in regard to the DVG. From the interviews it is clear that it is up to R&D personnel themselves to take responsibility for reading the DVG and using the content.

Available resources
In the same way this factor affect R&D as the long-term source it affects R&D as the long-term knowledge recipient. Resources and time needs to be available for R&D to e.g. have time to read about components in the DVG and reuse the knowledge. From the interviews no interviewees say that they have any specific time allocated for reading the DVG. There will always be a trade off between reading the DVG and do other tasks which are usually more urgent.

Routines for reusing knowledge
One factor affecting KD in the long-term is R&Ds lack of routines and guidelines for reusing knowledge, and especially content from the DVG. No standard structure or processes are evident from the interviews. The use of the DVG differs between R&D employees and it is unclear how and when the DVG should be used and who should use it.

Motivation
The interviews with R&D individuals reveal that the DVG is hardly ever used. This is an issue since knowledge from QJs is usually stored in the DVG. In two of the studied QJs DVG updates was done. Goh (2002) argues that IT-systems as means for dissemination of knowledge have potential to work out, but it requires motivation. Duan et al. (2010) states motivation as a key factor leading to KD success and Kalling (2003) states that motivation needs to be in place for intra-organizational KD. The personnel at VGT have a quality oriented mindset and shows good intentions to learn and reuse learnings, but other available sources of knowledge might restrict their willingness to use the DVG. Further, there is currently no way of demonstrating the usage of knowledge from the DVG, which also might negatively affect the motivation of using the DVG.

6.3.3.4 Media

Clarity of the Knowledge Dissemination media purpose
The clearly most prominent media for KD from todays R&D organization to the R&D organization of tomorrow is the DVG. The DVG is stated as the most important tool supporting KD in almost all interviews. It is positive that everyone recognizes the tool and understands it is a tool for KM. Nonetheless, the non-coherent understanding of the specific purpose of the DVG among different R&D departments and between individuals is a factor impairing its usefulness. It is unclear how and when the DVG should be used and by who. It is unclear if the DVG should store general component knowledge for others than the GCRs or store detailed knowledge about the component and identified quality issues for the GCRs only. Some argue it should be a bit of both. The main understanding today is that the DVG is used to store general knowledge about the component for new employees and design engineers, not for GCRs owning the component. Interviewees also state that they read about other GCRs components in the DVG and that they did read about their own component as new employees. However, the results show that GCRs hardly ever reads their own DVG except when they update it. This is not unexpected if the DVG mostly contains general component knowledge. The GCRs probably possess deeper and newer knowledge in their head.

In the last years, knowledge about specific quality issues from e.g. QJs has started to be added to the DVG. This change in content is more aligned with GCRs as the intended readers. Depending on the specific purpose and the intended reader the content in the DVG should be very different. If GCRs are the intended user and readers they are not today using the DVG as the support tool it could be. Furthermore, Pedersen et al. (2003) show in their study on Danish multinational companies that up to one third of all of the observed combinations (being choice of media combined with knowledge characteristics) were mismatches. An unclear purpose of the media used can clearly be a factor having a negative effect on the KD. Pedersen et al. (2003) also state that that explicit knowledge is

more likely to be transferred through written or electronic modes, while tacit knowledge should be transferred via rich communication media. They also conclude that in reality, this is seldom done.

Usability of the Knowledge Dissemination media
The DVG is the most used media for long-team KD at R&D. However, its usability is a factor negatively impacting the use of it. The usability is both about using the DVG and also about the design of the DVG. In the interviews it is stated that it is not easy to add content to the DVG due to error messages, content disappearing and software crashes. R&D interviewees state that today the DVG is also structured as if VGT always develops their components in-house. This is not always the case, which makes it hard to update the DVG for bought components. It is clear that this affects the individuals updating the DVG. It is unknown if this also have an affect on the DVG reader but that is likely. All these issues decrease the motivation to do DVG updates. According to a number of authors e.g. Reige (2005) and O'Dell and Grayson (1998), a mismatch between individuals' need requirements and technology will restrict KD practices. This means the structure of the DVG needs to be aligned with the needs of the KD source as well as the recipient.

Redundant Knowledge Dissemination tools
Many tools are available and can be used for KD at VGT. The DVG might be the most prominent media at R&D but there are other tools that R&D can use as sources for knowledge, e.g. QJWBs and Argus. Redundant tools with similar content are a factor having a negative effect on the KD for mainly two reasons. Firstly, the source is less inclined to neatly add content to a specific media, e.g. the DVG, since someone else also probably should add the same content elsewhere. A likely reason for this behavior is probably the negative attitude to double work and the opportunity to work less relying on the fact that knowledge will be stored anyhow. This is related to Reige's (2007) barrier of intrusive and extra work. Secondly, as stated in the interviews it is hard for the recipient to know in what media to search for knowledge since the same knowledge can be stored in multiple places and also some media may only contain parts of the knowledge. It might furthermore be problematic for the recipient to gain access and understand how the different tools work. The interviews suggest that Argus is a tool where this issue occurs. Reige (2005) also confirms that a lack of familiarity and experience with IT systems is a negative factor for using them as KD tool. It should however be stated that redundant tools can be reasonable since they assist in making sure the knowledge is at least stored somewhere and since writing knowledge in many places might increase the perceived importance of it. If redundant tools are kept they need to have clearly communicated purposes.

6.3.3.5 Activity

Time lag between the actors
When R&D tries to disseminate knowledge for future reuse, the source and recipient do not necessarily exist at the same time. The source will not know when the knowledge will be reused. Also, the source will not know who will receive the knowledge, even if it can be assumed that it is an individual/group with similar competence working in a similar context. The time lag is consequently relevant from the creation of knowledge to its future reuse. With the reasoning from Davenport and Prusak (2000) that a knowledge asset increase in value the more it is used, it is reasonable to assume that also the opposite is true. On the other hand it might be impossible for the recipient to find and interact with the knowledge source. This time lag will clearly affect the communication between the two actors as without a two-way communication it is impossible for the source to adapt the knowledge content based on recipient feedback. Using the research framework as a model for this KD the time lag will be a factor since the KD in this situation can only be one way. Successful KD without a two-way communication will be hard since no feedback loop can exist. Reige (2005) states that communication and knowledge flows that are restricted

into certain directions are a factor. At the same time another clearly evident factor described by Reige (2005) is the lack of contact time and interaction between knowledge sources and recipients. To the researchers knowledge, the time lag factor has not previously been described in this way in literature in regard to KD. It is however unknown if the research framework used has been applied as a model for KD over time before, where both actors does not exists simultaneously. It can be discussed if a framework based on a communication model is suitable for this kind of situation.

Frequency of interaction with the Knowledge Dissemination media
Despite the time lag it is possible to analyze the intensity and the frequency of the actors interaction with the knowledge stored in e.g. the DVG. It is clear that the R&D organization, as a source, rarely update the DVG content. The GCRs furthermore rarely reads the DVG in regard to their own component but sometimes they read about others' components. It is not known how often knowledge in the DVG are reused. However, this low frequency of interaction with the content in the DVG might be a factor having a negative effect on the KD, as it indicates that knowledge from the DVG are seldom reused. It however depends on the purpose of the DVG. If the DVG should be a tool used in the daily work by the GCRs this is probably an affecting factor but if the DVG is more of a tool for understand others' component in general this might not be an affecting factor. Generally speaking a higher frequency of the interactions with the KD media seems to be positive for the long-term KD at R&D.

6.3.3.6 Content

Addressability of knowledge content
This factor is considered to have the same effect on KD in the long-term perspective as for KD in the short-term perspective.

Sensitivity of knowledge content
This factor is considered to have the same effect on KD in the long-term perspective as for KD in the short-term perspective.

Validity of knowledge
Knowledge is continuously revised, developed and refined. Some knowledge might therefore turn non-valid after time due to big design changes or major development. For example, if a components design is changed significantly, the knowledge regarding the old design might lose its perceived value. Also the intention and willingness to manage it might be affected. This attitude have been acknowledge in some interviews with R&D individuals.

6.3.3.7 Context

Key Performance Indicators on the Knowledge Dissemination media
Internal documents at VGT show that R&D has KPIs on the DVG, e.g. frequency of DVG updates for a component and percentage of topics worked on for that component in the DVG. However, during the interviews these KPIs were only identified at one instance. Even if there are KPIs in place their effect on KD is small since they are not widely known. The lack of working KPIs on KD leads to smaller efforts being put into KD by VGT personnel. Goh (2002) means that measurement and reward systems that take into account collaboration and sharing of best practices can play a critical role in encouraging KD. Also O'Dell and Grayson (1998) state measurements and reward systems as enablers for KD.

Alignment between knowledge reuse and KPIs

Conflicts between goals in the QJ process and at R&D can sometimes impair knowledge from QJs to be disseminated to R&D and used in R&D projects. KD success from a QJ can be if QJ created knowledge could be reused in an ongoing R&D development project since the top goal for a QJ is to improve the product quality. This can however conflict with project gates at R&D as well as project KPIs on lead-time since taking action on the new knowledge would prolong the project. The studied QJA is an example of when this has happened. The alignment between reusing knowledge and VGT KPIs are therefore a factor affecting KD.

7 Discussion

This chapter contains discussions of various topics in regard to the study. The researchers' intention is to initiate a brief discussion about some matters that have been seen in the study but not thoroughly explored and consequently not treated in the analysis. Theses topics concern important aspects of KM that are not influencing factors of KD, the progress of the study and the research methodology chosen.

7.1 Successful Knowledge Dissemination

For KD from QJs at VGT to be truly successful it must be successful both in the short-term time span, e.g. capitalizing knowledge in the DVG, as well as in the long-term time span e.g. actually reusing stored knowledge by taking design actions to build in product quality knowledge from previous QJs. Based on the evaluation of the studied cases the success rate is judged to be high at least for the short-term dissemination of knowledge. In all the studied projects a corresponding design action was taken and a decision of updating DVG content was made in two of the three studied QJs. However, judging with certainty whether these projects were successful in disseminating knowledge in the long-term is not possible, since they were examined relatively close after the QJ end. To get an answer, it must be evaluated if the knowledge obtained will affect future design actions.

7.2 Design Verification Guidelines database effectiveness

The DVG is an important tool for KD as concluded previously. The effectiveness of the DVG is however tricky to assess. There are some KPIs on the use of the DVG and the completeness of its content, but these KPIs are more or less unknown. Even if individuals are asked if they have read DVG content and they state so, it is difficult to know how much of their knowledge they actually have assimilated from the DVG. As long as there are individuals possessing the same knowledge as is stored in the DVG that is an alternative knowledge source. Individuals probably always try to achieve knowledge in the most convenient way. It is therefore hard to measure the true effectiveness of the DVG as long as there are available individuals carrying the same knowledge and it is as easy to get knowledge from them as from the DVG. Further, what measures that are relevant for assessing the effectiveness of the DVG is also an issue worth analyzing. This has not been covered in this study because the DVG is a tool used by R&D, and it contains knowledge from many sources not just QJs.

7.3 Technical knowledge and process technical knowledge

VGT sometimes talks about product quality issues in terms of technical root causes and process technical root causes, in order find a solution to a problem. It seems like, the technical root causes are easier to identify and easier to address. One explanation from this could be that for VGT it is easier to solve a problem by fixing the technical root cause. Consequently it is also maybe more convenient to look for a technical problem root cause rather than finding the problem on the process technical side. The study has not gathered sufficient data to support this hypothesis, however the researchers perception is that process technical knowledge is more difficult to manage for VGT.

7.4 Knowledge Management strategy

During the short-term KD, VGT relies mostly on personalization as a method for KD. Therefore, meetings, collaboration and personal interaction are means for communication and KD in the short-term perspective. This is contrasting to the long-term KD were codification via the DVG is the main strategy. It has been shown that companies with successful KM have a strategy where they rely heavily on one of the two methods (80-20 rule), personalization or codification (Hansen et al. 1999). R&D has clearly chosen their strategy for long-term KD and put faith in the DVG as codification tool. Whether or not that is the correct strategy is not investigated in this study, but the pros and cons can be discussed since the strategy affects the outcome of KD. As a codification tool, a whole lot of knowledge and information can be stored. It will explain the same thing for each and everyone and it is the "*organization's memory*", where nothing will be forgotten unless it is deleted. However, the communication will not be as rich as an interaction between individuals and the content cannot be specifically adjusted to its future recipient. The strategic choice of KM approach in this case seems to be more emphasized on helping a workgroup to remember and access knowledge rather than communicating rich and personalized knowledge. A risk regarding this strategy is difficulty to distinguishing knowledge from information, and consequently suffer from information overload, or missing the tacit dimension of knowledge.

7.5 Knowledge Dissemination to other recipients

The data collected in order to answer the first sub research question in this study converged relatively early to conclude that R&D was one of the most significant recipients of QJ created knowledge. The convergence made the researches narrow the scope to focus on R&D as the acknowledged recipient. However, suppliers and other functions such as Purchasing, Aftermarket and GTO, was involved in the studied QJs as well and cannot be ignored in this context. It might be difficult for VGT to influence the suppliers' way of managing QJ created knowledge, but it would probably benefit both parties if suppliers joined forces with VGT on this matter.

7.6 Push or pull knowledge flow

This study investigates KD overtime, in a short- and long-term perspective, a different view that the researchers could have applied is to investigate knowledge flows. From theories of lean product development it can be discussed whether the knowledge flow is pushed or pulled from the QJs. In the short-term KD, there is some evidence for a push of knowledge. This is expressed in some of the closing criterias for the QJs and in the initiatives from upper management to update the DVG content. At least there is a strong will in making knowledge available through pushing. Whether knowledge in the DVG gets reused in the long run depends of the knowledge pull flow. There has

to be an intention from the recipient to read the DVG and make use of its knowledge content. That intention will only exist if knowledge in the DVG is available and truly useful.

7.7 Methodology

The methodology used in this study has not been flawless but it that has also lead to insightful learnings. Starting the main study's interview series the plan was to only take notes and base the findings on those notes since the number of relevant scheduled interviews was vast and the time at disposal, was not. However, it was hard to get enough data richness in the notes and the decision was made to transcribe all interviews from the recordings. The next challenge appeared after all interviews were conducted and in the beginning of the major data analysis, the continuous data analysis was performed during the interview series. With an immense amount of transcribed data it was difficult to make concepts of data pieces since every piece could usually be analyzed in multiple ways and used to build different concepts. The concepts could also have been sorted into the research framework directly but was now sorted along the QJ process. This was in line with reality and VGT individuals' perspective.

7.8 Trustworthiness

Regarding the credibility of the study's findings the researchers believe they are solid. The researches have spent considerable time in the studied context, the interviews in the main study were carried out until they started to convert and some further validation was also performed. Furthermore, many of the identified factors are acknowledged in the literature, also from different times and regarding other contexts.

Since this study is based on a sample of three QJs the sampling is highly important for the generality of the findings to other QJs and processes in the setting. Since the three studied QJs was chosen based on suggestions there is a possibility that the individuals who suggested the QJs could have tried to influence the study's findings by deliberately suggesting certain projects e.g. to engage in some type of politics. This risk is considered small, and interviews with a more general focus on the QJ process and R&D, conducted in the last part of the main study interview series, supported the previously collected data specific to the studied QJs. Furthermore, all interviewees stated that they believed they shared the same opinions as others to a large extent. This does however not necessarily mean they really do.

A critique to this study is to what degree it investigates real behavior. Documents have been studied, as well as data from interviews, in order to understand how the roles interact in the QJ process. Marmgren et al. (2012) presents a conceptual framework describing real behavior in a process, where the three structures that influence real behavior are addressed. They are: explicit normative structure e.g. managements expressions on how things are done, document structure e.g. process map and tacit guiding structure e.g. subconscious ideas of how thing is done, see Figure 17. Note that this is not the same notion for tacit and explicit as earlier referred to as two dimensions of knowledge. This study has addressed all three structures, but not observed the real process in action. However, the framework by Marmgren et al. (2012) illustrates that the most influencing structure to real behavior is the tacit guiding structure, which in this study is represented by the conducted interviews, which is the source for most of the analysis the conclusions.

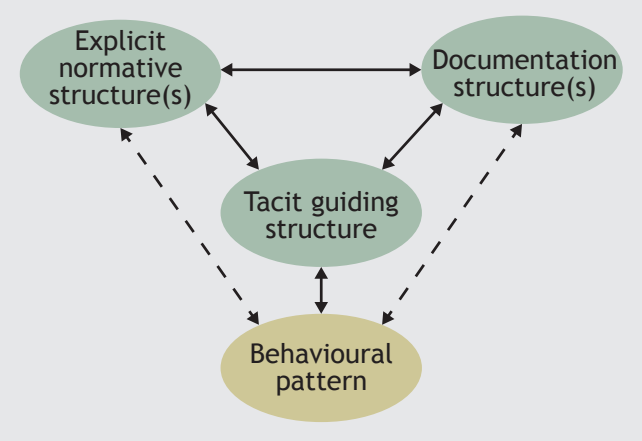

Figure 17 *Conceptual framework. (Marmgren et al. 2012, p.5)*

As described in chapter 2, the transferability of a qualitative case is questionable. Comparing factors already identified in previous literature nonetheless supports the likelihood of this study's findings being applicable to other contexts. In regard to the confirmability, the researcher background from a masters program in Quality and Operations Management, the initiation of the study from the department of Quality & Customer Satisfaction Strategy and the fact that the study was performed at QCS might have influenced the study's findings with a quality perspective. The researchers have throughout the study tried to be aware of getting biased and political influences, which are always present. Regarding if the findings have been affected due to potential influence from the researchers supervisors at GTT and Chalmers, the researchers have tried to rigorously assess feedback and ideas themselves before acknowledging them.

8 Conclusions

In this chapter key findings from the study are presented. The research questions are answered along with other significant findings and the study's contribution to the KM research field is described.

8.1 Recipients of disseminated knowledge

There are a number of potential recipients for knowledge disseminated from QJs. The characteristics of the quality issue will affect what departments are involved in the QJ and these departments are commonly knowledge recipients, e.g. R&D, QCS, Aftermarket, Purchasing and GTO. The main KD recipient is the R&D organization. The R&D organization is identified as the main recipient by the interviewees stating that R&D can take action to prevent reoccurrence of quality issues. R&D also own and are the main users of the most recognized tool for KD, the DVG. Other departments are furthermore usually depending on decisions made at R&D.

8.2 Factors affecting the Knowledge Dissemination

In this section the factors affecting the KD from QJs are summarized. The section is divided into one part regarding short time KD and one part regarding long time KD. The identified factors are listed together with their respective influence on KD. Positive linear relations are marked with a + sign, negative linear relations are marked with a - sign and n-shape factors with an n. There is also a column with VGTs perceived performance for each factor. This column indicates if VGT handles the factor well or if there is potential for improvements.

8.2.1 Influencing factors in the short-term perspective

All found factors affecting KD in the short-term perspective are shown in Table 4. The types of the factors are stated as well as their perceived performance at VGT. Figure 18 shows the factors as dots mapped in regard to the QJ process and the research framework.

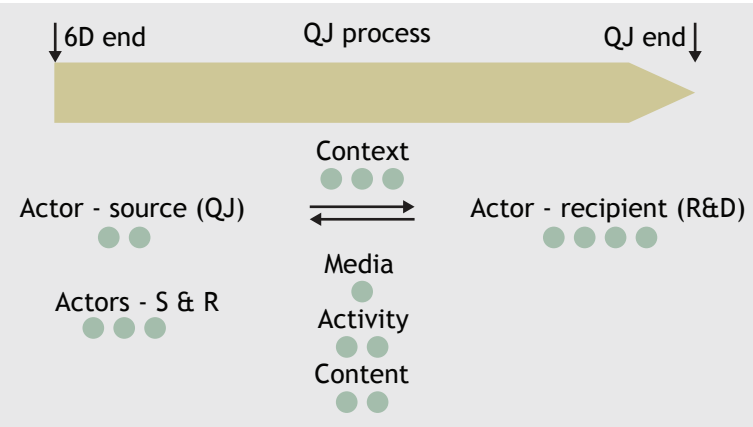

Figure 18 *Identified factors showed in the framework and along the QJ process.*

Table 4 *Identified factors influencing the short-term KD.*

Component	Factor	Perceived performance	KD relation
Actors - S & R	Knowledge distance	OK	-
Actors - S & R	Trust	OK	+
Actors - S & R	Attitude to Knowledge Managment	OK	+
Actors - Source	Clarity of responsibillities	Improve	+
Actors - Source	Sense of importance	OK	+
Actors - Recipient	Sense of importance	Improve	+
Actors - Recipient	Available resources	Improve	+
Actors - Recipient	Not-Invented-Here syndrome	Improve	-
Actors - Recipient	Timing between knowledge validation and knowledge capture	Improve	n
Media	Involvment	OK	+
Activity	Frequency	Improve	+
Activity	Feedback on actions for knowledge capture	Improve	+
Content	Addressability of knowledge content	Improve	+
Content	Sensitivity of knowledge content	Not determined	-
Context	Evaluation of the Knowledge Dissemination process	Improve	+
Context	Key Performance Indicators on Knowledge Dissemination	Improve	+
Context	Balance of the Knowledge Dissemination process	Improve	+

8.2.2 Implications in the short-term perspective

The factors in the short-term perspective relate largely to the interaction between people, which is the dominating way for KD between QJs and R&D. The responsibilities for KD are built upon mutual trust and personal initiatives. The trust is good in the team because of cross functional collaborations, which also aid to overcome knowledge gaps. However, there seems to be unclarities regarding the responsibilities for when and how to disseminate and receive knowledge, and the actors have different ideas of the importance of QJ created knowledge. Also, the feedback about the implemented solution is sparse. R&D gets little information from the market and QCS are not always sure about what actions R&D takes in order to prevent reoccurrence of the product quality issue.

Regarding the context for KD, the QJ process is impaired and heavily focused on problem solving and knowledge creation. There are KPIs on lead-time for the problem solving until the 6D step, but no KPIs on the later steps nor on the KD. The team is disseminated after the 6D step when the solution has been concluded in the MR-meeting and this is also when the project evaluation QJWB is finalized. Little resources are aimed at the 7D and 8D steps and there is clearly an uncertainty about when QJs actually ends.

8.2.3 Influencing factors in the long-term perspective

All found factors affecting KD in the long-term perspective are shown in Table 5. The types of the factors are also stated as well as their perceived performance at VGT. Figure 19 shows the factors as dots mapped in regard to the QJ process and the research framework.

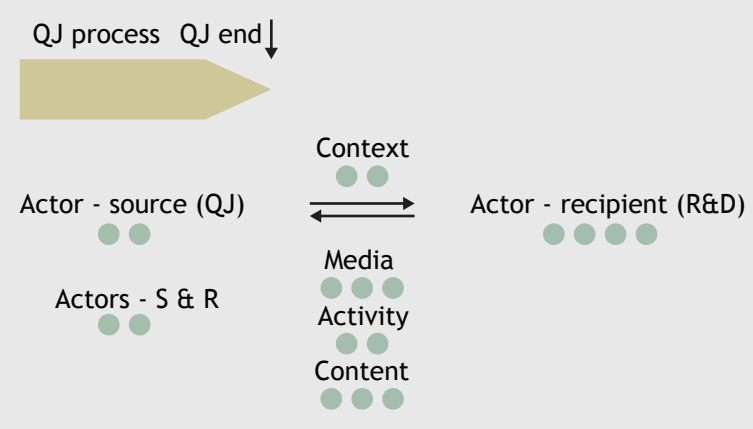

Figure 19 *Identified factors showed in the framework and along the QJ process.*

Table 5 *Identified factors influencing the long-term KD.*

Component	Factor	Perceived performance	KD relation
Actors - S & R	Knowledge distance	OK	-
Actors - S & R	Trust	OK	+
Actors - Source	Clarity of responsibillities	OK	+
Actors - Source	Available resources	Improve	+
Actors - Recipient	Clarity of responsibillities	Improve	+
Actors - Recipient	Available resources	Improve	+
Actors - Recipient	Routines for resuing knowledge	Improve	+
Actors - Recipient	Motivation	Improve	+
Media	Clarity of the Knowledge Dissemination media purpose	Improve	+
Media	Usability of the Knowledge Dissemination media	Improve	+
Media	Redundant Knowledge Dissemination tools	Improve	-
Activity	Time lag between the actors	Not determined	-
Activity	Frequency of interaction with the Knowledge Dissemination media	Improve	+
Content	Addressability of knowledge content	Improve	+
Content	Sensitivity of knowledge content	Not determined	-
Content	Validity of knowledge	Not determined	+
Context	Key Performance Indicators on the Knowledge Dissemination media	Improve	+
Context	Alignment between knowledge reuse and KPIs	Improve	+

8.2.4 Implications in the long-term perspective

In the long-term perspective many factors are related to the use of the DVG. Even if the DVG is considered the most important tool for KD in the long-term perspective it is rarely used accordingly. The intended use of the DVG is unclear and it is not known when or how often the DVG should be updated. Neither is it known who should read the DVG or when. R&D is lacking routines for reusing knowledge and the use of the DVG differs between R&D individuals and R&D departments. Also R&D has little resources and time for updating, reading and reusing content from the DVG. This is the case even if updating the DVG is a closing requirement for QJs. In reality, the long-term KD is like in the short-term time perspective also based on individuals, with an increased risk of losing knowledge due to personnel turnover. Davis et al. (2005) concludes that:

> *Knowledge sharing and management systems and processes in large global companies need to be integrative and flexible enough to facilitate the dynamic interplay between different forms of knowledge across the space and time.*

8.3 Contributions to the research field

This study have contributed to the KM research field by identifying factors affecting KD in a product quality improvement setting at a global automotive company and compared them with factors described in previous research. Further, the study have novelty used the KD theoretical framework presented by Paulin (2013) to analyze a KD setting and also confirmed its usability and applicability in this specific KD setting. The framework has also been used to analyze other KM activities than KD, e.g. knowledge capture and knowledge reuse, and to analyze KD in both a short and a long time perspective, see Figure 20. By using the framework to analyze KD over time, in a long-term perspective where the actors cannot have two-way communication, one factor not described in the same way in the KM literature has been identified, the time lag factor.

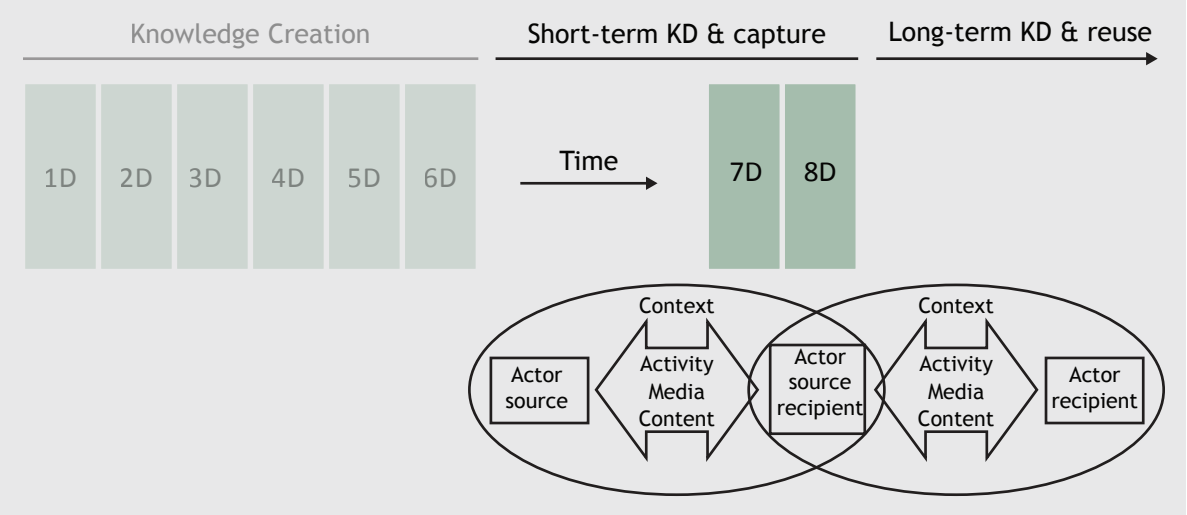

Figure 20 *The research framework used for analyzing KD.*

9 Recommendations

The researchers recommendations for VGT are divided into three sections in this chapter. The recommendations have been focused on QCS and R&D since these departments are acknowledged as central for KD from QJ projects.

9.1 Knowledge Dissemination in the short-term perspective

KPIs, or similar drivers, should be implemented for the QJ process step 8D to enforce its importance and to balance reactive and preventive quality improvement actions. The real QJ end must also be clearly communicated to make sure preventing reoccurrence is acknowledged as a part of the QJ process. To evaluate and improve all steps of the QJ process there is a need of additional evaluation conducted at the end of the 8D step in order to summarize and conclude knowledge generated during the entire process. Reflecting on the QJ project progress and the QJ created knowledge as currently done in the QJWB in the 6D step is not sufficient since the knowledge, and the justification of it, is at risk of later being ignored. Regarding who should have KD responsibility, the PMQJs and PQLs does not have authority to update the DVG and they do not have the skill to determine the DVG content quality. Also, they do not possess equal insight to the R&D organization and the DVG as the R&D members. The R&D members should therefore have responsibility for KD to R&D. Also, QJs are only one source of knowledge regarding R&D components. It is possible for the PMQJ and PQL to have responsibility for getting the DVG update done but it must be up to R&D to ensure the quality of the content. Furthermore, if the PMQJ and the PQL would continue to be responsible for following up the solution and the preventive actions, they need authority to fulfill their task even if adding content to the DVG is not a QJ closing criteria. Also there is a need to evaluate the solution on the market, and indirectly the root cause, before adding knowledge to the DVG in order to make sure the knowledge is considered a justified true belief.

9.2 Knowledge Dissemination in the long-term perspective

To improve and structure the usage of the DVG as media for long-term KD, resources and support should be increased to enforce knowledge to be added to the DVG and to increase the reuse of knowledge from the DVG. For example, if the QJ conclude that the DVG should be updated, resources and time has to be provided from the QJ to perform the update. Furthermore, both QCS and R&D personnel needs education about the purpose of the DVG, its intended use, what are suitable knowledge and the DVG acknowledged reader. For example, the DVG content should motivate reuse and be actionable. The performance and use of the DVG should also be measured to ensure its usefulness and enforce its use.

9.3 Actions to take

In order to bring clarity to when knowledge from a QJ should be documented, the use of a preliminary knowledge storage media, a “preliminary DVG”, is recommended before justified knowledge can be added to the DVG. Knowledge should be added in the 6D step before the QJ team is disseminated. This will make use of the recommended extra resources provided by the QJs to ensure knowledge capture at R&D. It will also facilitate capturing the knowledge when it is fresh in mind. The QJ team as well as the R&D organization will know that the documentation have been done, and both parties will know that the other part knows. However, the DVG content cannot be justified at this stage, due to lack of market response, and can not be referred to as knowledge yet. The justification will be available after the 7D step but the work related to the knowledge codification will have been done before.

The second recommendation is a joint meeting with the QJ team, similar to the MR-meeting, in the 8D step after the effectiveness of the implemented solution have been confirmed. Recommended participants for this meeting are the PQL, the PMQJ, the GCR, potential design engineers, QCS and R&D auditors, and if needed personnel from Aftermarket, Purchasing and GTO. The purpose of this meeting is to jointly evaluate the implemented solution and take a decision regarding updating the DVG with content from the “preliminary DVG” based on the result of the market validation. If the solution is not sufficient the QJ team have to consider initiating a new QJ or other actions. Content will also be added to the QJWB in this step to reflect the whole QJ process.

The third recommendation is to clarify the purpose and intended use of the DVG. The DVG is a media for KD and its purpose must guide the reader to take action on its content. General information and descriptions about a component might be useful to some extent, but may not always help readers to take decisions. The use of the DVG as a check sheet is one idea that would imply a more concrete way of reading and using the DVG as an aid to design new components and products.

The fourth recommendation is to educate VGT personnel of the clarified purpose and intended use of the DVG. This is necessary for R&D personnel since they are the main users of the DVG but also for QCS personnel since the DVG is closely linked to the QJ process and especially to the 8D step of preventing reoccurrence. The education should address how the DVG can be used in order to prevent reoccurrence of quality problems but also how the DVG should be written in order to be comprehensible and useful for the intended reader.

9.4 Perform a complementary study

VGT should perform a complementary study to this one but on KD from QJs regarding Vehicle Engineering. Since the QJ process for Vehicle Engineering is to some extent different from the QJ process used in regard to Powertrain Engineering, other factors might be influencing the KD. This can allow VGT to find best practice.

10 Further research

KD is a vast area for further research. In this chapter, some recommendations for further exploring the subject based on the findings in this study are presented. The suggestions reflect the research framework used and the factors identified.

10.1 Further investigate knowledge reuse

This case study investigated three quality projects and focused on how knowledge was disseminated from them. In the short-term KD perspective, KD success involves an action to capture knowledge and in the long-term perspective an action to reuse knowledge indicate KD success. The DVG has a central part in this study, for the capture and the reuse of knowledge. The codification strategy is not exclusive for VGT and similar tools are used for capture and reuse of knowledge by other firms. This study focused on tracking knowledge created in a QJ project, but the time frame restricted the possibility to investigate the reuse of particular knowledge. Instead, more generic investigations were made when exploring the reuse of knowledge. As a recommendation, the knowledge reuse can be more investigated. A deeper understanding for knowledge reuse from documents could give practical implications for companies with a codification KM strategy, and for VGT it could bring more clarity to how knowledge is handled from QJs.

10.2 Quantify the impact of the identified factors

The factors identified in this study are not quantified and therefore it is difficult to determine their magnitude of impact on the KD. To investigate this would be interesting for GTT but also for the KM research field. It would be interesting to get a better insight into which factors facilitates KD the most and which factors that serves as the biggest barriers for KD from product quality improvement projects at a global automotive company.

10.3 Identify the correlation between factors

The factors identified in this study are explained as having a positive or negative influence on the KD. However, the respective correlation for each factor could be more complex than just linear correlation. Exploring if other correlations exist would broaden the understanding of KD in general but for the factors in particular. Also the study has not investigated the interdependencies between the identified factors. It has neither been determined if there are any interdependencies nor how potential interdependencies look like. Understanding the relationship of interdependent factors and analyze how potential synergies appear can contribute to the research area of KM.

10.4 Investigate the time lag factor

Using the research framework on a set of knowledge activities over time revealed the time lag factor. This factor is worth investigating further since the researchers have not found an identical factor in the KM literature. It would therefore be interesting to deeper explore this factor and its influence on KD.

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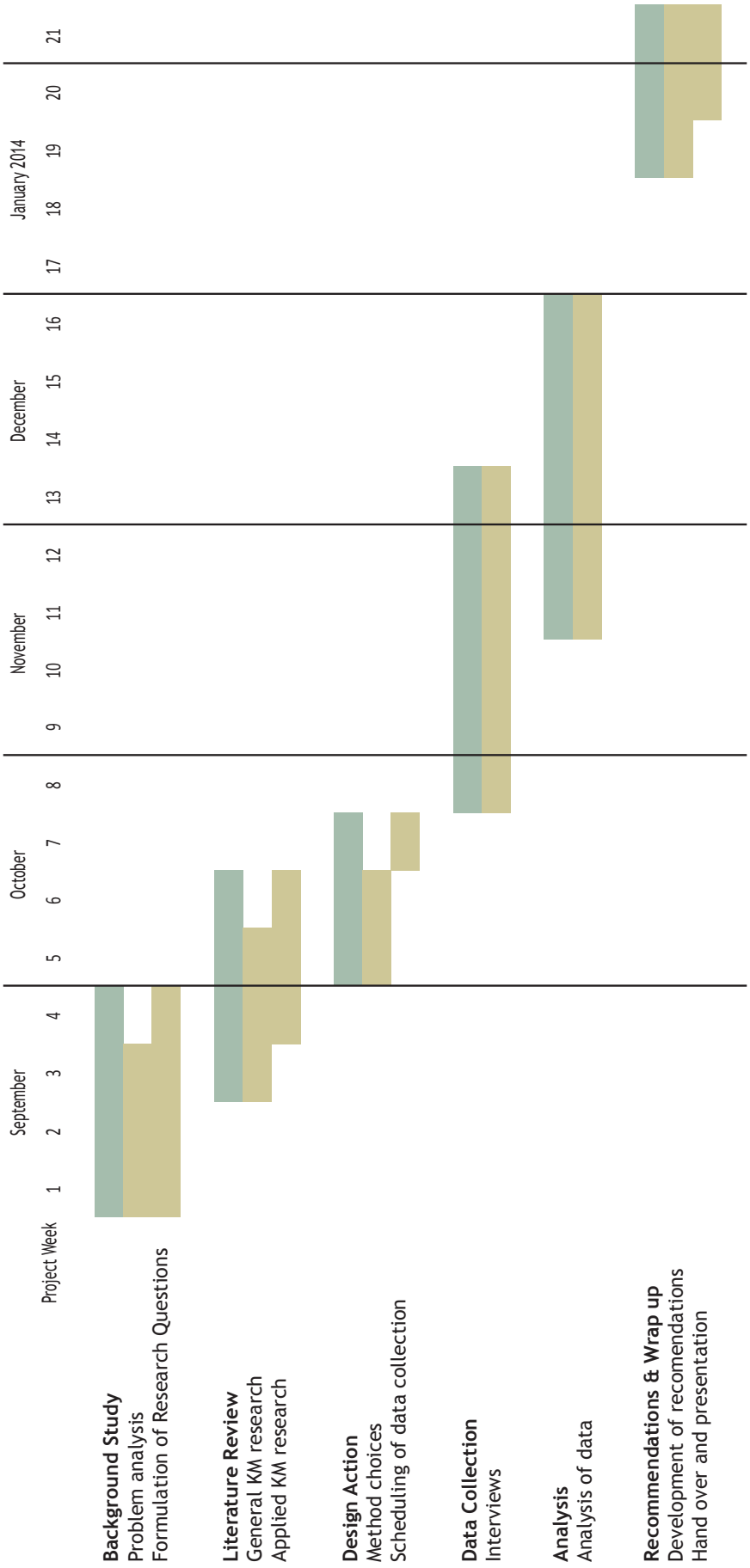
Appendix

Appendix 1 - Project plan
Appendix 2 - Interview guide

Appendix 1 - Project plan



Appendix 2 - Interview guide

Below is the part of the interview guide that was used before all interviews begun.

Researchers background
Names, Students from Chalmers, Academic backgrounds

Purpose of the thesis and the thesis outline
- September 2013 - January 2014
- Supervision at QCS, name of supervisor
- Understanding Knowledge Dissemination from QJ projects and identify areas of improvement
- The perspective on Knowledge Dissemination is inter-organizational, where the QJ-team constitute the source
- Three reference QJs selected. You have participated in one of them
- Interviews will be held with persons from each of the reference projects and also acknowledged recipients of the QJ created knowledge
- We want to interview you in order to understand how the QJ-team disseminates knowledge from QJ projects

Use of data
- The data collected will set the base for the analysis and conclusions
- You will of course see the results
- You will be invited to a presentation and also get the written report

Anonymity
- All interviewees will be treated anonymously
- No data collected, and presented in the thesis, will be possible to trace to you.

Ethics
- You can decide whether or not you want to answer a question
- You are free to withdraw from the interview whenever you want
- No questions will be asked about why a question was ignored or why you wish to leave the interview, if that would be the case

Duration
- Approximately 1.5 hours
- We have a couple of questions based on a framework for Knowledge Dissemination. We would like to get through as much as possible to get the most complete picture possible.
- Can we record the interview?
- We will use our cellphones as recording devices
- We will also take notes
- Do you want to ask us something before we start?