Revealing knowledge workers' tacit knowledge usage in the product development department of an automotive manufacturer

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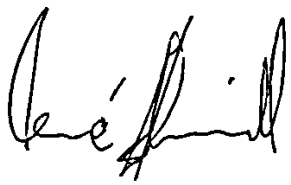
Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Worcester and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

Any views expressed in the thesis are those of the author and in no way represent those of the University.



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Abstract

This study seeks to explore the application of tacit knowledge by knowledge workers in the development department of a multinational auto manufacturer. While the existing literature on tacit knowledge outlines the importance of tacit knowledge to organisational performance (Nelson and Winter, 1982; Sternberg *et al.*, 1995; Spender, 1996; Baumard, 1999; Gore and Gore, 1999; Jafari, Akhavan and Nourizadeh, 2013), research on tacit knowledge is still underrepresented (Brown and Duguid, 1998; Holtshouse, 1998; Leonard and Sensiper, 1998; Zack, Rand and Wilsh, 1999; Garcia-Perez and Mitra, 2007; McAdam, Mason and McCrory, 2007). Authors in the field of tacit knowledge including Kabir (2013), McAdam, Mason and McCrory (2007), Sumbal *et al.* (2017), Holtshouse (2010) call for further research in the field of tacit knowledge related to the identification of tacit knowledge and the potential of using specific methods in research on and management of tacit knowledge. Furthermore only a few studies on tacit knowledge in the automotive sector exist. Hence relatively little is known about tacit knowledge usage in the automotive sector.

The aims of this study are 1) to identify specific tacit knowledge frequently used by knowledge workers in the product development department of a multinational car manufacturer and 2) to further explore the tacit knowledge usage by eliciting how and why it is used in achieving organisational goals.

This embedded researcher single case study in the product development department of a multinational automotive company employed a mixed methods approach conducted in two sequential steps. The quantitative first step analysed internal job advertisements for evidence of epitomes of tacit knowledge (Haldin-Herrgard, 2003) and discovered the areas of the highest concentration of application of such. The second step used semi-structured interviews to discover the “hows” and “whys” of tacit knowledge application in the frequently used forms – skills, experience, and abilities – in achieving organisational objectives of automotive development.

This research contributes new knowledge in research on tacit knowledge in the automotive sector as called for by Jafari, Akhavan and Nourizadeh (2013) as well as the call by Kabir (2013) for the development of an approach to identify tacit knowledge in organisational data.

The concept of epitomes of tacit knowledge (ETK) developed by Haldin-Herrgard (2003) is employed in this research and makes use of quantitative content analysis and elicits tacit knowledge from organisational data. Although it contributes new knowledge on how epitomes of tacit knowledge can be conceptualized to act as a construct for managing tacit knowledge as demanded by McAdam, Mason and McCrory (2007). ETK were used in the context of

content analysis to quantify the amount of tacit knowledge and to identify frequently applied forms of tacit knowledge in different knowledge worker positions. With the approach of quantifying the amount of applied tacit knowledge by knowledge workers in different positions employed in this research, this research contributes new knowledge on assessing the risk of possible knowledge loss in case of employee leavings, thus answering a request from Sumbal *et al.* (2017) and Holtshouse, (2010). The upshot is that tacit knowledge intensive positions can be identified and classified according to the amount of potential tacit knowledge loss. Finally, the results provide new insights into individual applications of 1) tacit knowledge in the form of social skills to facilitate development work in this department 2) tacit knowledge in the form of experience in knowing what has or has not worked in the past so as to avoid problem-related inefficiencies, and 3) tacit knowledge in the form of abilities to approach and solve problems – all three of which are combined and applied as means of reaching the product development goals of this multinational automotive manufacturer.

Acknowledgements

“Every journey in life starts with the first step” (Lao Tsu) - I have encouraged myself with this statement every time I pull out a blank sheet of paper to start something new. Now, forty-seven months later I arrived at the end of my DBA journey. Looking back, I can safely say that I regret nothing. What started out with high expectations of myself – as well as some inner doubt - has ended with a very satisfying result. The achievement of satisfaction in this journey is related in a great part to the support of different people.

In this section of my thesis I want thank all those people who guided, supported and encouraged me. First and foremost, I would like to thank my supervisors Dr Robin Bell and Dr Vessela Warren for their great guidance. I experienced a great team approach during this entire process. Dr. Robin Bell tirelessly and patiently guided me from the start of my DBA journey onwards in a way I never experienced before. Dr Vessela Warren stepped into a supervisory role after one of my initial supervisors had to quit due to personal circumstances. In quickly coming up to speed in this role, Dr Vessela Warren demonstrated great commitment to guiding me in my study. Without the help of both supervisors this thesis would not exist in the way it is.

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List of Abbreviations

PDD	- Product Development Department
ETK	- Epitomes of Tacit Knowledge
KIBS	- Knowledge-Intensive Business Services
PKIBS	- Professional Knowledge-Intensive Business Services
TKIBS	- Technological Knowledge-Intensive Business Services
EG13; EG14; AT, LL6	- Classification of Salary Groups
HASSREC	- Humanities, Arts and Social Sciences Research Ethics Committee of the University of Worcester
Tx	- Main-theme
Tx-STx	- Sub-theme

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Chapter 1: Introduction

1.1 Background to the study

Knowledge in an organisation is recognized as a crucial resource (Toffler, 1990; Drucker, 1991; Quinn, 1992; Nonaka and Takeuchi, 1995; Leonard and Sensiper, 1998; Davenport and Prusak, 2000). Knowledge is a highly valuable organisational resource that must be protected against loss. Loss of organisational knowledge occurs when an organisation no longer has access to knowledge which was formerly part of the organisational knowledge structure and sources (Joe, Yoong and Patel, 2013; Massingham, 2018). Knowledge loss in organisations is an effect of employee turnover, lost codified knowledge (e.g. breakdown of data storage devices) or knowledge decay (Winkelen and Mcdermott, 2008; Joe, Yoong and Patel, 2013; Massingham, 2018). Losing organisational knowledge can lead to a decrease in efficiency, reduction of competitiveness and losses in organisational capability and advantage (DeLong, 2004; Massingham, 2008).

With the retirement among later baby-boomers, the risk of organisational knowledge loss due to employee leaving the company is reaching a critical peak in companies across different industries and geographies (Lesser and Rivera, 2006; Holtshouse, 2010; Ball and Gotsill, 2011; Levy, 2011; Joe, Yoong and Patel, 2013). The current share of workers older than 50 years of age is 35 % of German employment (Statistik Bundesagentur für Arbeit, 2018; Statistisches Bundesamt, 2018). Partial retirement programs and an increase in the sickness rate of employees older than age 50 will intensify the leaving rate of employees in German enterprises over a ten-year time frame (Dachverband der Betriebskrankenkassen, 2016). Further intensifying the demographical component of employee turnover is the increased use of temporary workforce measures in organisations. The temporary workforce share overall in German employment is 3% or roughly, 991,000 employees. In the second quarter of 2015, 691,000 employee positions were filled by temporary workforce service, while to the same time 717.000 temporary workforce contracts were terminated (Bundesagentur für Arbeit, 2017). Numbers such as these demonstrate the high rate of employee turnover linked to temporary workforce services.

The facts above create a dramatic picture of the potential loss for knowledge in German organisations related to increased employee losses over the next ten years.

1.2 Defining knowledge

Knowledge a term which is well known and often used in society (Sparrow, 1998). In *Theaetetus,* Plato first defined knowledge as “justified true belief”, a definition of knowledge which is also commonly accepted today (McDowell and Brown, 2014). “Knowledge evolves when information is combined with experience, context, interpretation and reflection” (Davenport, De Long and Beers, 1998, p. 43). North, Brandner and Steininger (2016) describe the development of knowledge as beginning with characters. By adding syntax to these characters, data evolves. Adding semantics to the data, information evolves. Crosslinking and organising information, knowledge evolves. The description of knowledge development made by Davenport, De Long and Beers, (1998) as well as by North, Brandner and Steininger (2016) shows that structuring and organizing are essential processes in creating knowledge. According to Marakas (1999, p. 264), knowledge is the result of organizing ideas, rules, and procedures. Knowledge is mainly distinct in tacit and explicit knowledge (Nonaka and von Krogh, 2009).

Tacit knowledge is knowing-how (Grant, 1996b). It is knowledge that is embedded in a person based on experience and includes intuition, beliefs and insights (Polanyi, 1966). Verbalisation of tacit knowledge is difficult; which makes tacit knowledge hard to identify, not easy to store or to transfer to another person (Fleck, 1996; Gore and Gore, 1999; Seidler-de Alwis and Hartmann, 2008). The terms implicit knowledge and tacit knowledge refer to the same kind of knowledge and are often used as synonyms for knowledge with the above-highlighted characteristics.

Explicit knowledge can be interpreted with knowing “what” (Brown and Duguid, 1998). Explicit knowledge is knowledge that can be easily verbalized, codified in written form, and stored in documents or databases. This type of knowledge is easy to identify and easy to transfer (Kane, Ragsdell and Oppenheim, 2005). Hence it describes information that can be used to act, decide on, or perform accordingly (Polanyi, 1966; Nonaka and Takeuchi, 1995; Brown and Duguid, 1998; Smith, 2001; Nonaka and von Krogh, 2009).

Nonaka (1994, p. 15) claims that the terms information and knowledge are often interchangeably used. According to Nonaka (1994, p. 15) “information describes a flow of messages and knowledge is created and organized by the very flow of information, anchored on the commitment and beliefs of its holder”. Nonaka (1994) creates with this an understanding of knowledge which is generated by humans. Quinn, Anderson and Finkelstein (1996) see in the personal knowledge of an individual, who is part of an organisation, the intellectual capital of an organisation. Thus, organisational knowledge is the sum of knowledge possessed by different individuals. Organisational knowledge compromises explicit knowledge stored in

documents and databases and tacit knowledge that is embedded in the workers' minds (Guzman and Wilson, 2005).

1.3 Research problem and context

Around the world in the next decade later baby boomer employees – those born later in the period between 1945 and 1964 – will be leaving their organisations and retiring (DeLong, 2004; Ball and Gotsill, 2011; Joe, Yoong and Patel, 2013; Sumbal *et al.*, 2017). Researchers like Ball and Gotsill (2011), Sumbal et al. (2018) and De Massis *et al.* (2016) have identified these workers as experts who are holding a great deal of knowledge which makes them essential to organisational performance. In leaving, these employees take their knowledge forms with them (Joe, Yoong and Patel, 2013). Calo (2008), Ball and Gotsill (2011) and Stevens (2010) link the retiring of these employees to intensive organisational knowledge loss. The upcoming wave of retirements which is linked to knowledge loss in German organisations poses a significant risk for efficient organisational performance. According to Ball and Gotsill (2011) the manufacturing sector will be most heavily impacted by retirements. Levy (2011) and Calo, 2008 (p. 405) emphasise that knowledge intensive organisations will have to cope with the continuous loss of unrecoverable knowledge. The focus of this research is on the product development department of a multinational automotive manufacturer or in short PDD (Product Development Department). The PDD was selected because this is a knowledge-intensive functional group. It is classified as knowledge intensive because the main share of workers in this organisation are well educated, highly qualified, and deeply involved in development activities that are primarily intellectual (Pina e Cunha, 2002; Alvesson, 2003; Lee, 2003; Swart and Kinnie, 2003). The intellectual core competencies in this department are the processing and generating new knowledge from which the organisation can benefit (e.g.: new products, innovations, creation of processes to increase efficiency). One aim of this organisation function is to create intangible organisational value.

The organisation in which this research was conducted is a multinational car manufacturer headquartered in the USA which employs more than 200,000 employees in about 90 different plants worldwide. The company designs, manufactures, and sells automobiles and commercial vehicles. The European business section develops, produces, sells, and services vehicles in fifty markets in Europe. Round about 52,000 employees are directly employed by this European business section. Six body and assembly plants are located in Europe. Furthermore, seven engine production plants and five transmission production plants belong to this European business section and are located in Europe as well. The German unit of the company employs in total 24,900 employees from which 18,500 employees are based in the western part of Germany. The enterprise is a main economic driver in this region. Many suppliers of

this company are located very close to the manufacturer´s plant of the manufacturer. The production plant employs 14,878 employees.

Product development is carried out at four different locations within Europe. The whole European product development section employs 8,590 employees. This work concentrates on the product development section based in Germany which is closely located to the production plant in the western region. The German product development section contains 4,215 employees. 17% of these positions are management positions. 87% of the employees from the product development section in Germany are men and 13% are women. The overall average age of employees in the product development section is 45 years of age. Workers older than 50 make up to 37% of the department, a couple of points higher than the overall percentage in Germany (35%) for workers 50 and older (Statistik Bundesagentur für Arbeit, 2018; Statistisches Bundesamt, 2018). 16 % are older than 55 years of age. Hence, the likely turnover rate in the next ten years in this organisation is significantly high. The organisational knowledge loss potential is due to the age distribution seen in this department. These losses are mainly triggered by demographic aspects as described above which lead to regular and early retirements.

According to Sumbal, Tsui and Lee (2015) and Ball and Gotsill (2011) organisations cope with this situation achieving varying results in outcomes. While failure is linked to poor management decisions and budget shortfalls in the field knowledge management, success is based on an early realization of the aging workforce and the establishment of appropriate knowledge retention actions (Ball and Gotsill, 2011). In meetings between the researcher and the organisation`s human resource department, working council and the management, the researcher recognized that all parties are aware of the aging workforce and are concerned about the potential knowledge loss linked to the upcoming wave of retirements. In these conversations the researcher also understood that no concrete measures for assessing the risk of potential knowledge loss seemed to be established. Hence, this organisation needs to start preparing for this scenario. Massingham (2018, p. 722) classified previous research on the loss of knowledge into three themes according to impact: First, the impact of knowledge loss on the remaining employees with respect to psychological effects such as decreased morale and productivity. Second, the impact of loss of subject matter expertise, expertise that leaving employees take with them, which may result in a noticeable loss of know-how and experience in the organisation. Third, the impact on organisational capability that may appear in decreased performance and productivity. Due to the projected increase in employee turnover in the organisation being researched, this thesis concentrates on the knowledge that employees potentially take with them by leaving the organisation.

Polanyi (1958) states that employees leaving the organisation take with them their tacit knowledge. Letmathe and Rößler (2019) highlight the challenge of tacit knowledge loss in engineering companies facing an aging workforce. Polanyi (1958, 1966), describing tacit knowledge as personal knowledge, embedded in personal experience, context-related, based on awareness, and involving personal factors such as beliefs, perspectives, instincts, and values. Tacit knowledge is widely acknowledged as an essential element of business success and a crucial advantage for any enterprise (Nelson and Winter, 1982; Sternberg and Wagner, 1987; Nonaka and Takeuchi, 1995; Grant, 1996b; Brown and Duguid, 1998; Sparrow, 1998; Birchall and Tovstiga, 1999; Sternberg *et al.*, 1999; Busch and Richards, 2004; Rashid, Bin Hassan and Al-Oqaily, 2015; Sliwa and Patalas-Maliszewska, 2015; Dudek and Patalas-Maliszewska, 2016; Jisr and Maamari, 2017). According to Polanyi (1966), tacit knowledge does not occur in an explicit form, but instead in representations. Such representation of tacit knowledge in its application have been observed by the researcher. Manager and engineers in meetings and conversations in the PDD often refer to a feeling which cannot be described more specifically or explicitly, but nevertheless led to decisions on next steps to be taken in different situations and activities in the organisation. Activities like problem solving, strategy planning or conversations that are important to the performance of the organisations. After starting the literature review on the topic of tacit knowledge and becoming familiar with the nature of tacit knowledge, the researcher retrospectively identified the representations of tacit knowledge application in these observations. Following the experience of the researcher on the potential application of tacit knowledge and the common position in the literature on the importance of tacit knowledge to an organisation, it was determined that the loss of tacit knowledge in an organisation due to increased rate of retirement has to be reduced or to be avoided.

The countermeasure of knowledge loss is knowledge retention. Knowledge retention is one goal of successful knowledge management. Compared to research on the management of explicit knowledge, research on the management of tacit knowledge is very limited according to Leonard and Sensiper (1998). Explicit knowledge based on such characteristics as being easy to verbalize, storable in databases and documents, and easy to transfer, seems to be a less complex field for research compared to research on tacit knowledge (Kane, Ragsdell and Oppenheim, 2005). Tacit knowledge is not easy to verbalize, to store, or to transfer; it is personal knowledge and context related (Polanyi, 1966; Nonaka and Takeuchi, 1995; Gourlay, 2003; Gascoigne, 2013). The key aspect of knowledge management for capturing explicit knowledge is in the use of information technology, tacit knowledge remains largely underexplored due to its abstract nature. Authors like Venkitachalam and Busch (2012) highlight the lack of understanding on the contextualisation of tacit knowledge in an organisation. Kabir (2013) expresses the need for knowledge that enables an organisation to

identify tacit knowledge resources in organisational data. McAdam, Mason and McCrory (2007) promote closing the gap in knowledge on the potential of using epitome–based approaches for research on tacit knowledge. Epitomes of tacit knowledge (ETK) are verbalized indicators for the use of tacit knowledge. A more detailed explanation on the use of epitomes in research on tacit knowledge takes place in a later chapter in this thesis. Sumbal *et al.* (2017) and Holtshouse (2010) call for a development of risk assessment measures that identify potential organisational knowledge loss through turnover as well as establish knowledge retention action guidelines. All authors call attention to gaps in research on the basis of managing tacit knowledge. Managing knowledge to achieve knowledge retention by knowledge transfer in an organisation requires the identification of critical knowledge that is essential to organisational performance (De Long and Davenport, 2003). This critical knowledge should be transferred and with this retained in the organisation (Levallet and Chan, 2019). The identification of critical tacit knowledge can only be done by understanding the usage of tacit knowledge in an organisation. Understanding the use of tacit knowledge in this knowledge intensive organisation contribute to a theoretical foundation for successful tacit knowledge management with the intention of organisational tacit knowledge retention.

1.4 Purpose of the research

The literature shows that there is a broad field of methods used for identifying and formalising tacit knowledge in organisations. Methods used for identifying tacit knowledge are observation techniques, Repertory Grid, mapping techniques, the Delphi method, and storytelling. Variety in the application of different methods is driven by the aim of the related research, the environment in which the research was carried out as well as to the difficulties on identifying tacit knowledge in related contexts. Within the broad field of applied methods for the identification of tacit knowledge in the organisations, the literature lacks mixed methods studies on tacit knowledge in the automotive section (Massaro, Dumay and Garlatti, 2015). The view from multiple angles on the phenomenon by combining quantitative and qualitative methods can help to achieve a broader picture of the phenomenon. It also reduces the possibility of blind spots which appear by applying each method separately on a phenomenon to be explored. Reducing these blind spots reduces also weakness in the research results (Webb, 1976; Denzin, 1989; Gray, 2009). In times where resources in organisations are limited and maximum efficiency for each process is mandatory, research conducted in an enterprise has to consider the limitation of resources and high efficiency expectations by the management. Research in an organisation is expected to be straight and efficient. Locating tacit knowledge in an organisation to conduct research on, is based on the hidden character of tacit knowledge, as such it is potentially time and resource intensive exercise. To overcome the barrier of detecting tacit knowledge and to achieve high efficiency in this research, the researcher

decided to use a theoretical concept out of the field of tacit knowledge research not applied in the automotive sector before.

The theoretical concept developed from Haldin-Herrgard, (2003), uses epitomes of tacit knowledge (ETK). Haldin-Herrgard, (2003) identified ninety-two epitomes of tacit knowledge that in any context facilitate the verbalization of the use of tacit knowledge (Haldin-Herrgard, 2003). This concept enables the researcher to use existing secondary data from organisational sources to identify and to locate the use of tacit knowledge in this organisation.

This sequential research consists of two steps. The concept of ETK is implemented in a quantitative research method applied to secondary data of this organisation in research step one. The results of the application of this quantitative method create the theoretical foundation for research step two, the qualitative aspect in this research. This qualitative method concentrates on primary data to achieve a deeper understanding on the phenomenon of tacit knowledge in this context.

The first step for introducing sufficient knowledge retention actions is to identify critical organisational knowledge (De Long and Davenport, 2003). The importance of tacit knowledge for the performance of an organisation as highlighted in the literature and outlined above, tacit knowledge is recognised as knowledge that is critical in the PDD. To explore tacit knowledge in the PDD environment it is essential to find its possessors. Because this research focuses on potential organisational knowledge loss due to greater employee turnover it is necessary to identify positions that are critical with respect to tacit knowledge usage. Critical means in this context to concentrate on positions that require a high amount of tacit knowledge to perform. Employees working in these positions would take in case of leaving the organisation a high amount of tacit knowledge with them.

The aim of this research is to identify specific tacit knowledge that is frequently used by knowledge workers in the product development department of a multinational car manufacturer and to further explore the tacit knowledge usage tendencies by eliciting how and why it is used.

The first research question (RQ1) incorporates the need for identifying these critical positions.

RQ1: How does the usage of job-related tacit knowledge differ between knowledge workers in different positions within the product development department of a multinational automotive manufacturer in Germany?

To answer the first research question the differences in the amount of required tacit knowledge in the PDD for different positions need to be assessed. This assessment helps to identify the knowledge workers in the PDD that require the highest use of tacit knowledge to perform efficiently in their position.

To increase the level of depth in exploring tacit knowledge and to deliver a robust understanding on the use of tacit knowledge, as well as to make tacit knowledge manageable, this thesis elicits knowledge workers specific tacit knowledge usage in the PDD. Specific tacit knowledge is frequently used and essential to the performance of the PDD. Therefore, specific tacit knowledge in the PDD that is frequently used by knowledge workers in the PDD to guarantee job performance, would be classified as critical knowledge. Hence is the second research question:

RQ2: What specific tacit knowledge is frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

To establish recommendations for prioritizing knowledge retention actions in the PDD and to reduce tacit knowledge loss in case of greater employee turnover the integration, context and purpose behind the use of the specific tacit knowledge frequently applied by knowledge workers in the PDD is investigated. Understanding how and for what purpose specific tacit knowledge is frequently applied by knowledge workers in this department completes the picture of tacit knowledge usage that is critical of reaching the product development goals of this multinational automotive manufacturer. This is addressed in research question RQ3 and RQ4:

RQ3: How is specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

RQ4: What is the purpose for the application of specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

1.5 Research objectives

The following objectives guide this research:

This first objective describes the goal to classify knowledge workers in the PDD according to the amount of tacit knowledge usage required to perform in their position. Achieving this objective will answer research question one. It also narrows the field of study to knowledge worker positions in the PDD that exhibit highest usage of tacit knowledge. These positions are due to the amount of tacit knowledge usage most critical in case of employee leavings.

The first objective is: To quantify tacit knowledge usage of knowledge workers in the product development department of a multinational auto manufacturer.

The second objective seeks to narrow the field of investigation to specific tacit knowledge that knowledge workers in the PDD frequently use. This enables the researcher to focus on performance-sensitive tacit knowledge forms in the PDD.

The second objective is: To identify specific tacit knowledge that is frequently required for performance from knowledge workers in the product development department of the multinational auto manufacturer.

The third objective concentrates on situating the identified specific tacit knowledge frequently used by knowledge workers in the PDD to organisational activities. By eliciting these linkages, deeper insides on the use of tacit knowledge in the PDD are to be achieved.

The third objective is: To identify the contexts where specific tacit knowledge is frequently used by knowledge workers in the product development department of the multinational auto manufacturer.

The fourth objective completes the total picture of tacit knowledge usage by knowledge workers in the PDD. Achieving the fourth objective situates tacit knowledge usage in activities carried out in the PDD and helps to answer research question four.

The fourth objective is: To analyse the aim behind the use of tacit knowledge by knowledge workers within the product development department of the multinational auto manufacturer.

The results of this thesis on the application of tacit knowledge by knowledge workers in the PDD are used for a recommendation to the multinational car manufacturer, to prioritize tacit knowledge retention actions in the PDD in a period of greater employee loss. Furthermore, the findings of this research deliver essential insights on the use of specific tacit knowledge by knowledge workers in this department. The organisation can use these findings to establish actions within the PDD to stimulate the development of specific tacit knowledge traits which are performance sensitive to the department. The knowledge created in this research could help to prepare the organisation for the upcoming increase in retirements of ageing employees and delivers a better understanding for the organisation of the role of tacit knowledge usage and its related effects in the fulfilment of the PDD objectives.

1.6 Research design summary

This thesis explores the phenomenon tacit knowledge in two sequential steps. The first step in this research overcomes the barrier of identification and location of tacit knowledge usage in the organisation participating in this study. There is a common agreement in the literature that identifying tacit knowledge is one of the major challenges in tacit knowledge research (Gore and Gore, 1999; Ambrosini and Bowman, 2001).

In this first step, a quantitative approach of data gathering takes place. This quantitative approach builds on the theoretical framework developed by Haldin-Herrgard (2003) as a method to identify and locate the use of tacit knowledge. This method enables this initial research step to overcome the aforementioned barrier of locating tacit knowledge usage. Haldin-Herrgard (2003) used epitomes of tacit knowledge as indicators for the use of tacit knowledge. As already described, ETK are concepts that facilitate the verbalization of the use of tacit knowledge (Haldin-Herrgard, 2003). Hence, if these ETK appear in any context, the use of tacit knowledge can be identified and located.

In the first step of data gathering, organisational secondary data is investigated. Internal job advertisements in the PDD from various knowledge worker positions are analysed with respect to the use of epitomes of tacit knowledge. While job descriptions mainly refer to general conditions like responsibilities, authority, level of autonomy or working conditions, internal job advertisements refer to more specific attributes (e.g. skills, experience, educational background or abilities) an employee must possess to be able to perform successful in the related position. Hence job advertisements contain attributes of an employee where the use of tacit knowledge is deeply interwoven. Using internal job advertisements to quantify the differences in the usage of tacit knowledge across multiple positions in the PDD addresses the need for new knowledge on identifying tacit knowledge resources by reviewing available organisational data as demanded by Kabir (2013). De Long and Davenport (2003) recommend as a first step for successful knowledge retention the identification of areas in the organisation with critical knowledge. Critical knowledge in an organisation is knowledge that is essential for an organisation to perform (De Long and Davenport, 2003). Quantifying the differences in the amount of tacit knowledge usage among knowledge workers in different positions by counting epitomes of tacit knowledge in the PDD internal job advertisements helps to narrow the field of research to knowledge workers with the highest use of tacit knowledge. Because these high tacit knowledge workers are also building the body of organisational knowledge, they collectively constitute a critical knowledge source and, by extension an elevated loss risk in the foreseeable future retirement wave. Hence is the focus of this research on these specific positions. Similar to the negative impact on the performance of the PDD the leaving of knowledge workers who possess the highest amount of tacit knowledge would have, is the negative impact for the PDD in losing specific tacit knowledge which is frequently used in these positions. Frequently-used tacit knowledge stands for tacit knowledge that is highly performance sensitive. The ETK concept from Haldin-Herrgard (2003) is used by the researcher to identify tacit knowledge in the form of ETK frequently used in these knowledge workers positions. The identification of distribution patterns of tacit knowledge in the form of ETK between different positions helps to identify specific tacit knowledge in the form of ETK frequently used in the PDD. Identifying knowledge workers with the highest use of tacit

knowledge and also identifying specific tacit knowledge frequently used in this context helps this research project to concentrate on the most critical variables of knowledge loss potential in the PDD retirement cases. The data gathering and analysis in the first research step creates a picture of how the use of tacit knowledge varies in the PDD and what specific tacit knowledge is critical to organisational success. The results of the first research step build the theoretical foundation for the thesis' second research step. Using in this first research step the theoretical concept of ETK from Haldin-Herrgard (2003) delivers new knowledge on the potential of using epitome-based approaches for research on tacit knowledge as claimed also by McAdam, Mason and McCrory (2007).

The second research step further explores the application of specific tacit knowledge frequently used by knowledge workers in the PDD. To achieve this deeper level of exploration the researcher uses a qualitative approach of semi-structured interviews. Authors in research on tacit knowledge commonly agree on the usage of interview techniques for eliciting tacit knowledge as an appropriate approach for achieving deeper insights on tacit knowledge (Ford and Sterman, 1997; Sternberg *et al.*, 1999; Ambrosini and Bowman, 2001; Goffin and Koners, 2011). Knowledge workers demonstrating the highest amount of tacit knowledge usage in their position, those identified in research step one as most critical resources with respect to knowledge loss related to increased employee retirement, are interviewed. Thematic analysis is conducted to analyse the data gathered in these interviews. By using thematic analysis, the researcher further explores the usage of specific tacit knowledge in the form of ETK frequently used in the PDD. The purpose of this qualitative second research step is to understand how tacit knowledge is used in the PDD to achieve what purposes. This step uncovers the conceptual ideas of specific tacit knowledge usage in the context of the PDD and helps to connect the use of specific tacit knowledge to organisational activities essential for the performance of the PDD, ultimately addressing the aim of this research.

In summary, research step one as quantitative step in this sequential research locates the positions with the highest use of tacit knowledge and identifies the most critical resources of tacit knowledge usage in the PDD. Furthermore, ETK are used to define specific tacit knowledge frequently used in the PDD. This specific tacit knowledge in the PDD is likely to be essential to organisational and individual performance. Research step one answers the questions of how the usage of tacit knowledge differs and what specific tacit knowledge in the form of ETK is frequently used in the PDD. Research step one builds the theoretical foundation for research step two by narrowing the field of investigation to the most critical variables of tacit knowledge usage in the PDD.

For the qualitative approach in research step two semi structured interviews with knowledge workers in the PDD are conducted. Thematic analysis is applied to the interview data to explore

the activities where tacit knowledge is frequently used by the PDD knowledge workers and to elicit the purpose behind the usage of specific tacit knowledge frequently applied in the PDD. Step two is needed to support the findings from research step one and to concretise the understanding of the usage of tacit knowledge in the context of organisational activities.

Because research step two builds on the results from research step one, each of these research steps has its own results section. The overall results of this sequential research generate a crucial understanding of tacit knowledge usage by the PDD knowledge workers and allows the researcher to make recommendations to this organisation for prioritizing knowledge transfer actions to reduce knowledge loss in an unusually elevated retirement rate period.

Chapter 2: Literature review

Knowledge is commonly recognized as a key factor for success in organisations (Toffler, 1990; Drucker, 1991; Quinn, 1992; Nonaka and Takeuchi, 1995; Leonard and Sensiper, 1998; Davenport and Prusak, 2000). Working with and on knowledge varies from organisation to organisation, but the work on knowledge in organisations is mandatory for an organisation to stay innovative and competitive (Wheeler, 2002; Sandhawalia and Dalcher, 2011). This literature review begins with understanding the work on knowledge in organisations. The links between work on knowledge in organisations to tacit knowledge, to the actors involved, and to the knowledge work carried out in the PDD of the multinational auto manufacturer are highlighted. The importance of knowledge workers to an organisation is outlined and the relationship between tacit knowledge and knowledge workers is explained. The existing definitions of tacit knowledge and the perceived roles of tacit knowledge in organisations are discussed. The reader is introduced to the approach of using epitomes of tacit knowledge (ETK) framework developed by Haldin-Herrgard (2003) to identify use of tacit knowledge. Finally, tacit knowledge is contextualized in knowledge management. In summary, this chapter will link the work on knowledge in organisations to the use of tacit knowledge in the PDD. In the context of knowledge management, thus highlighting the need for research on tacit knowledge in this context.

2.1 Work on knowledge in organisations

In discussion of work on knowledge in organisations, the phrase Knowledge Intensive Business Services (KIBS) will likely arise. Miles *et al.* (1995, p. 18) describes the functional contents of KIBS as: “involving economic activities which are intended to result in the creation, accumulation or dissemination of knowledge”. These economic activities are carried out by expert firms serving client companies the knowledge output resulting from investigative activities (Toivonen, 2006). Miles *et al.* (1995) distinguish between two different forms of KIBS: 1) Professional Knowledge Intensive Business Services (PKIBS) are related to business and management services, market research and accounting; 2) Technological Knowledge Intensive Business Services (TKIBS) are related to engineering, IT services and consulting in research and development. The client`s staff members serve as the central resource in the process of eliciting and creating knowledge for business solutions (Den Hertog, 2000; Larsen, 2001; Muller and Zenker, 2001; Bettencourt *et al.*, 2002). Muller and Doloreux (2009, pp. 67–69) state that KIBS are no longer seen by scholars only as transferors of specific information, but they are also recognized as innovators and carriers of changes. According to Wood (2002) there is no common definition of what KIBS are. Strambach (1997, p. 35) states: “Specialised expert knowledge, research and development ability and problem solving know-how are the

real products of KIBS". Windrum and Tomlinson (1999) outline, by referring to Strambach, (1997) that manufacturing firms, that are typical clients of KIBS, can be differentiated from KIBS according to the characteristics of their output. While the output from manufacturing organisations containing a high degree of codified knowledge, the output from KIBS do contain a high amount of tacit knowledge. KIBS helps an organisation to produce knowledge which is often strategically or technical significant (Wood, 2002). Hence, KIBS access these resources to extract tacit knowledge. The activities in the PDD in which the study in this thesis is conducted has similar characteristics to the activities carried out by KIBS in an enterprise. The PDD has a central role in the company in product innovation and troubleshooting as well as creating know-how and delivering knowledge to the rest of the organisation. Understanding the role of a worker in an organisation as well as understanding the type of work these workers are performing seem to be essential steps for research on tacit knowledge in organisations.

2.2 The evolution of the concept of the knowledge worker

Bell (1974) suggested that industrial society organized around men and machines to generate output will develop into a post-industrial era, socially controlled by knowledge. Drucker (1999) explained that now since the central challenge of making manual workers more productive is solved and principles for efficiency improvements are established, the management has to concentrate on making another specific type of worker more efficient, a specific group of workers becoming the largest single group of workers in every developed country. The type of worker Drucker (1999) referred to is mainly engaged with analysis, planning, organising, creating, and adjusting information with the aim to extract value from the knowledge produced in related tasks. This description which undergirds the prediction from Bell (1974) regarding a change in the core competencies of an industry. Attributes like analysis, planning, organising, creating and adjusting information describe core competencies of a worker in the product development section of an enterprise. Drucker (1999) called this type of work "knowledge work" and the type of worker performing this work a knowledge worker.

2.2.1 Knowledge work

Knowledge work is often described as work which builds on intellectual and cognitive processes (Drucker, 1959; Heerwagen *et al.*, 2004). The term knowledge work was first coined by Drucker (1959) in reference to an increase in complex work tasks requiring highly- educated and highly qualified workers to apply theoretical knowledge in industries. Terms like technical know-how, analysis, creation, planning, networking, problem solving, product development, innovation, and information are used in the literature to build a framework for defining knowledge work (Heerwagen *et al.*, 2004; Higgs and Hender, 2004; Kogan and Muller, 2006; Amabile and Kramer, 2007). Knowledge work generates output which becomes another's input (Drucker, 2012). According to the literature, new products and new processes related to

problem solving, efficiency improvements, and applications (Scarbrough, 1999; Davenport, Thomas and Cantrell, 2002; Heerwagen *et al.*, 2004; Noon, Blyton and Morrell, 2013) often embody the output of knowledge work. According to Brown, Reich and Stern (1993) the process of knowledge work has a non-materialistic character. This view is already shared by Machlup (2014) who observed that the substance of this work is the process, not the product. Winslow and Bramer (1994) link knowledge work with the process of problem solving in an organisation, based on information analysis and knowledge application. The above mentioned characteristics of knowledge work describe the core activities of a product development group of an organisation. Sliwa and Patalas-Maliszewska (2015) note that knowledge workers are dominant in the field of R&D. Since the core competencies of the PDD in this researched organisation are product development, product innovation, problem solving, knowledge creation, process innovation and efficiency improvements, it is an ideal field for research on knowledge work and workers.

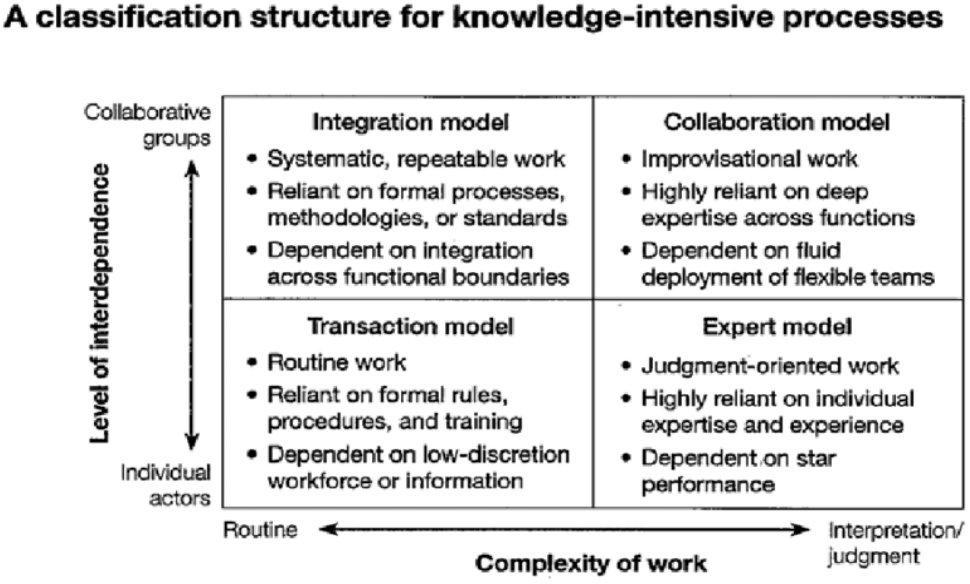
2.2.2 Knowledge worker

Whilst there is little disagreement about the importance of knowledge work and knowledge workers in an organisation, the definition of “knowledge worker” is not united. In Drucker's (1959) “The Landmarks of Tomorrow”, the ideas “knowledge work” and “knowledge worker” are referred to as productive work. “The man who works exclusively or primarily with his hands is the one who is increasingly unproductive. Productive work in today’s society and economy is work that applies vision, knowledge and concepts – work that is based on the mind rather than on the hand” (Drucker, 1959, pp. 119–120). Deducible from this statement is the idea that a knowledge worker is mainly employed in a cognitive sense. Pauleen and Gorman (2016) use the metaphor of knowledge workers as plough pulling working horses. In doing so they describe the leading and accelerating character of knowledge workers contribution to economic and organisational progress based on the cognitive work of knowledge workers. During the 1950s, ninety percent of the American workforce were employed in repetitive task jobs (e.g. working with hands) requiring minimal education; in the beginning of the twenty-first century two-fifths of this workforce already became knowledge worker (Acsente, 2010; Drucker, 2012). The workforce evolution from manual worker to knowledge worker is rooted in the rise of knowledge-intensive industries (Mokyr, 2003). Švarc (2015) explains that expertise, education and upskilling are products of the changed nature of labour which became distinctive factors of a knowledge worker. Furthermore, knowledge workers are responsible for innovation and organisational development, mainly engaged in the invention of new products, new services and strategies. Drucker (2002) claimed that knowledge, which is the main capital of a knowledge worker, is only effective if it is specialized, citing examples across a wide range of professional roles. Hammer, *et al.* (2004) extended the position from Drucker by adding that this person does know more of his or her job than anyone else in the organisation does.

According to these definitions, everyone in an organisation can be classified as a knowledge worker. Which brings up a question raised by Hammer, *et al.* (2004); if it is still seasonable to label someone a knowledge worker in an era where every job or role requires some amount of specific knowledge? Choi and Varney (1995) offer an even broader definition; knowledge workers are well-educated workers performing non-routine tasks dominated by thinking and decision making. El-Farr (2009) claims that knowledge workers rely on their personal knowledge more than on organisational knowledge. He describes organisational knowledge as knowledge which is available to all members of the organisation and personal knowledge as knowledge that is only within the individual and difficult to be imitated by others. The description of knowledge which is personal and difficult to be imitated implies that the dominant type of knowledge these workers are using is tacit knowledge. This can be underpinned by El-Farr´s (2009) statement with respect to the operational field a knowledge worker ideally performs in. El-Farr (2009) contends that the available literature strongly suggests that knowledge workers performing in abstract fields which are only accessible and workable by the use of tacit knowledge. Scarbrough´s (1999) conclusion is that knowledge workers are distinguished from traditional workers by their autonomy and a lack of boundaries in their field of activity. Blackler (1995) states that knowledge workers primarily use “embrained and encultured” knowledge, which is a fitting description for tacit knowledge as well.

Davenport (2002, 2005) developed the first segmentation scheme for knowledge workers. A model-based approach by Davenport (2005) with the aim to increase the productivity and performance of knowledge workers.

Figure 1: A Classification structure for knowledge-intensive processes from Davenport (2005)



The horizontal axis of the model displays the complexity of work from routine to interpretive. The vertical axis shows the level of interdependence from individual to collaborative work. This

segmentation scheme results in a four type's segmentation of knowledge work (Transaction Model, Integrated Model, Collaborative Model, and Expert Model). Davenport´s (2005) model classifies knowledge workers by work characteristics and gradation of collaboration, although it does not help identify knowledge workers in an organisation. Hammer *et. al.* (2004) claim that the Davenport model does not cover all characteristics of knowledge workers, thus it cannot be used to build upon on for identification of knowledge workers. However, Davenport *et. al.* (2004) present a more holistic view of the characteristics of knowledge workers. Davenport *et. al.* (2004) agree that all job tasks do need knowledge to some extend and that the most common perception of a knowledge worker is a worker with a high educational level, high expertise, and mainly occupied in the cognitive fields of creation, distribution, or application of knowledge. Using a U.S. Bureau of Labor Statistics worker classification system, Davenport (2005) categorizes managers and employees carrying out engineering work, as knowledge workers. Similarly, Sulek and Marucheck (1994) state that knowledge workers include: academics, doctors, engineers, and scientists. Sulek and Marucheck (1994) explain that this type of knowledge worker is highly educated, possesses a high level of experience, and is ranked highly in an organisation, furthermore is usually allowed to perform autonomously to fulfil tasks.

There is no doubt about the massive shift in the total share of knowledge workers, but the various descriptions of knowledge worker characteristics clearly demonstrate the lack of a common accepted definition of knowledge worker in the literature (El-Farr, 2009; Acsente, 2010). A circumstance, which makes a concrete demarcation between traditional workers and knowledge workers difficult. The missing rigor in science on the definition of the term "knowledge worker" leads to critique in literature and opens up room for discussion based on the existing different definitions on the term of knowledge worker.

From the most frequently found attributes in the literature review, it can be summarized that an ideal type of knowledge worker is a highly experienced and creative worker with an academic background or a high level of education. Such a worker constantly uses tacit knowledge and performs mostly autonomously in non-routine cognitive tasks applying knowledge to problem solving as well as the analysis and manipulation of information all of which generate value from knowledge for the purpose of increasing organisational success.

2.2.3 The importance of a knowledge worker to an organisation

The concepts of "knowledge work" and "knowledge worker" map out essential characteristics of successful organisational performance. These characteristics and the workers who possess them are responsible for product and process development as well as problem solving within an enterprise. The increase in the share of knowledge workers during the initial decades of the Information Age is explained by the contributions they make to the success and sustainability

of organisations where they are found. This goes hand in hand with the growing scale and diversity of companies in the sector of KIBS and TKIBS. Ultimately the vitality of national economies is heavily based on the access and application of knowledge by knowledge workers responsible for the growth and the competitiveness of their respective organisations and industry sectors (Martin, 1998; Engelbrecht, 2000; Kuo and Low, 2001; Blom, Melin and Pyöriä, 2002; Lavoie, Roy and Therrien, 2003; Palmer, 2006; Kohut *et al.,* 2007; Rigby and Bilodeau, 2007; Acsente, 2010; Holtshouse, 2010). Guthridge, Komm and Lawson (2008) weight the contribution of a knowledge worker to an organisation's profit as three times higher than that of a traditional worker. Drucker (1999) has stated that knowledge workers have an ownership in the means of the production. The statement judges the personal knowledge of these workers as crucial to the organisation's sustainability and makes them somewhat independent of the organisation with respect to problem solve and knowledge creation. In essence, they provide a symbiosis of characteristics and skills for organisational success.

Reasoning onward from these statements, a knowledge worker in an organisation should be perceived as a key resource requiring respectful attention from all management domains in an enterprise because the kind of knowledge owned by such a worker is critical to the foundation an organisation builds on. A circumstance which underpins the above described risk for organisational performance by a leave of these workers. According to Blackler (1995) and El-Farr (2009) tacit knowledge is the type of knowledge that a knowledge worker use to perform successfully in changing fields of activity. Hence, concentrating on knowledge workers tacit knowledge in this research means to concentrate on the very essential organisational knowledge sources.

2.3 Tacit knowledge characterized

2.3.1 The spectrum of knowledge

Every employee owns a degree of knowledge that qualifies him or her to perform daily job processes. The literature on business and organisation describes two types of knowledge, explicit and tacit knowledge (Nonaka and Takeuchi, 1995; Grant, 1996b; Davenport and Prusak, 2000; Smith, 2001; Nonaka and von Krogh, 2009). The explicit portion of that knowledge is defined as academic knowledge described in formal language in documents and other media, archived via data platforms, thus shareable (Weick, 1979; Argyris, 1993; Nonaka and Takeuchi, 1995; Fleck, 1996; Sternberg *et al.*, 1999, 2000; Davenport and Prusak, 2000; Smith, 2001). The tacit portion of this knowledge, personal knowledge is based on awareness embedded in personal experience, context related and involving factors such as beliefs, perspectives, instincts, and values cannot be easily stored, archived, or shared. Sharing this knowledge requires activities such as apprenticeship (or mentoring), face-to-face interaction, and active learning (Polanyi, 1958, 1966; Nonaka, 1991; Nonaka and Takeuchi, 1995; Dyer

and Nobeoka, 2000; Haldin-Herrgard, 2000; Gourlay, 2003, 2004; Seidler-de Alwis and Hartmann, 2008; Ray, 2009; Gascoigne, 2013). Nonaka and von Krogh (2009) as well as Ambrosini and Bowman (2001) emphasize that explicit and tacit knowledge should be seen as a continuum of knowledge where the one end is the explicit and the other end is the tacit end of knowledge. The continuum means that one concept cannot exist without the other.

2.3.2 Situating tacit knowledge in the field of knowledge management

Liebowitz (1999) makes clear that the concept of knowledge management is not really new to organisations. Maier and Hadrich (2007, p. 21) also emphasize that the concepts behind knowledge management are well known and are built around knowledge, intelligence, innovation and learning in organisations. The aim of knowledge management is to create organisational value from the organisational knowledge (Liebowitz, 1999). Segars, Gold and Malhotra (2001) highlight that most of the projects in an organisation called “knowledge management projects” are not in fact so. These projects are often information management exercises which do not have the processes and capabilities to create new knowledge in an organisation. Segars, Gold and Malhotra (2001, p. 186) find the key for successful knowledge management in the identification and assessment of preconditions and count this among the capabilities and resources of an organisation. Individual knowledge, a resource belonging to organisational members and integrated in organisational performance, is the essence of organisational capability and builds organisational knowledge (Grant, 1996; Tsoukas and Vladimirou, 2001). Thus, individuals’ knowledge builds the roots of organisational knowledge. In summary, it can be stated that the reviewed literature in the domain of knowledge management shows that organisational knowledge management facilitates all actions to process and handle knowledge in organisations.

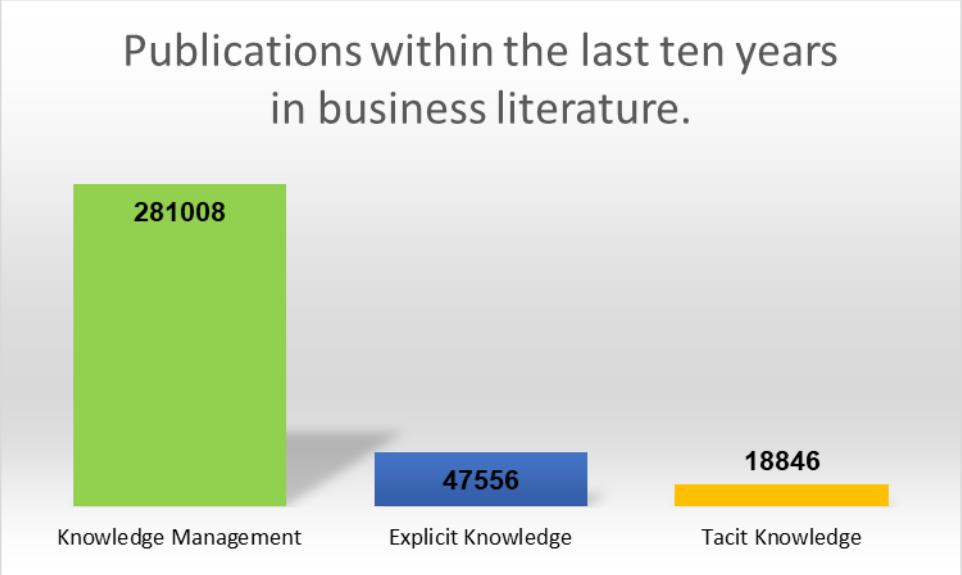
This thesis concentrates on individuals’ tacit knowledge, as part of organisational knowledge, embedded in members of an organisation. Papers and books in the field of knowledge management distinguish between explicit knowledge and tacit knowledge. While there is often a detailed explanation of the characteristics of explicit knowledge available, only a brief and general gloss over the characteristics of tacit knowledge is made. The current knowledge management literature is dominated by a focus on explicit knowledge, a circumstance Leonard and Sensiper (1998) note by calling attention to the lack of research on tacit knowledge management. Most studies in the domain of knowledge management are clustered around systems to store, handle, transfer, or protect explicit knowledge in organisation. The management of explicit data is mostly linked with information technology, a domain which systematically excludes tacit knowledge. Yet in the literature of knowledge management there is recognizable discussion around the identification of tacit knowledge and the feasibility of its measurement and transfer (Polanyi, 1966; Nonaka and Takeuchi, 1995; Grant, 1996b; Dyer

and Nobeoka, 2000; Garcia-Perez and Mitra, 2007; Venkitachalam and Busch, 2012). Focusing on specific authors regularly cited in tacit knowledge research opens up a general picture of its position under the header of knowledge management. Based on the Sternberg and Wagner (1987) theory that tacit knowledge is measurable, authors like Busch (2008), Richards (2000), Insch (2008), and Hedlund (2003) have developed their own models and theories to measure tacit knowledge. Yet, uncertainty in science of understanding tacit knowledge still exists. This uncertainty is not aided by a dominance in research on explicit knowledge a dominance is explainable by the characteristics of explicit knowledge – easy to verbalize, storable in databases and documents, easy to transfer – which make research on explicit knowledge less complex than research on tacit knowledge (Kane, Ragsdell and Oppenheim, 2005).

The literature review on the amount of literature published in the discipline of business in the last ten years related to the subject tacit knowledge versus the amount of literature related to the subject a) explicit knowledge and b) knowledge management, shows the imbalance between research on explicit knowledge versus research on tacit knowledge.

For this literature review, the University of Worcester library search machine powered by Summon was used with key word non-subjective search algorithms for business discipline publications over the last ten years. The keyword phrases were knowledge management (n=281,008), explicit knowledge (n=47,556), and tacit knowledge (n=18,846). Figure 2 below provides a quick visual comparison.

Figure 2: Total number of publications within the last ten years in business literature

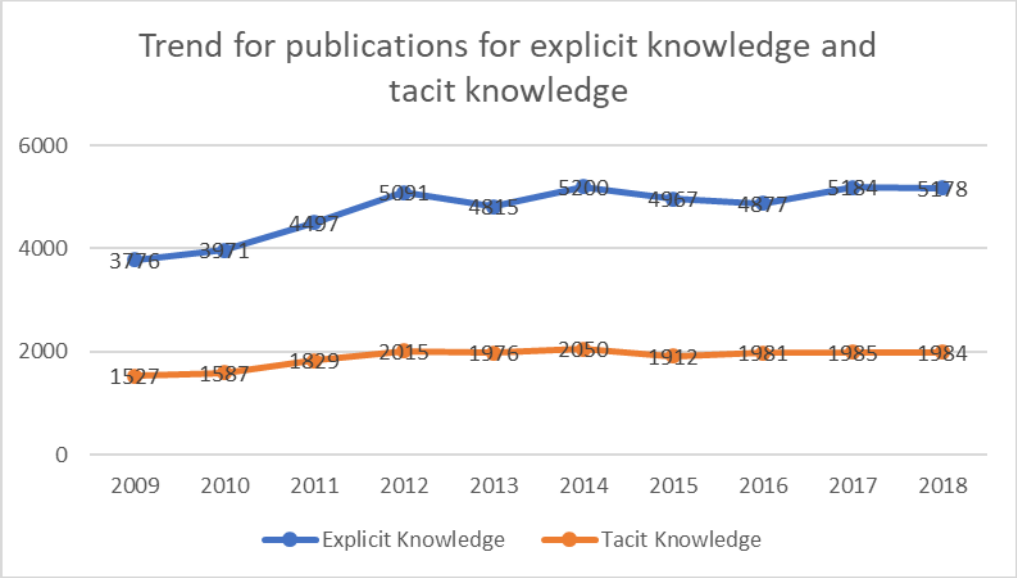


While knowledge management publications dominate the results of this exercise, the results for publications with the key words explicit and tacit knowledge are disproportionately weighted toward explicit knowledge. Publications in the domain of knowledge management mainly cover

aspects for managing and processing knowledge, whereas publications with the key words explicit and tacit knowledge cover essentials in the field of research on such knowledge. Hence existing knowledge management literature refers to explaining or classifying knowledge to the findings in the specific literature to both types of knowledge.

To get an understanding how research in the specific fields of explicit and tacit knowledge developed within the last ten years, the frequency of publications per year for business literature with the key words explicit and tacit knowledge was investigated. This investigation leads to the finding that research on tacit knowledge is still underrepresented and the growth for research on explicit knowledge is still dominant. Furthermore, the number of yearly publications with the key word tacit knowledge in business literature since the year 2014 decreased about 5%, while the decrease for the number of publications for the key word explicit knowledge is only 0,4%. The figure below shows the trend in the number of publications in the business literature for the key words' explicit knowledge and tacit knowledge within the last ten years:

Figure 3: Trend for publications for the key words' explicit knowledge and tacit knowledge



The identified numbers of publications in this literature review on tacit knowledge versus research on explicit knowledge shows that there is a lack for research in the field of tacit knowledge in the business literature. This statement is supported in the positions taken by different authors in the field of tacit knowledge (e.g.: Brown and Duguid, 1998; Holtshouse, 1998; Leonard and Sensiper, 1998; Zack, Rand and Wilsh, 1999; Garcia-Perez and Mitra, 2007; McAdam, Mason and McCrory, 2007). All these authors claim that research on explicit knowledge is far more often than research on tacit knowledge which cause a lack in understanding tacit knowledge. The comparative lack of published work on tacit knowledge paired with the high rate of decline in the publication of tacit knowledge research are issues

that the author of this thesis classifies as a risk to satisfying the research requirements leading to a robust understanding of the role of tacit knowledge in organisational knowledge management. Such a need is also corroborated by the authors McAdam, Mason and McCrory (2007); Holtshouse (2010); Kabir (2013), Sumbal *et al.* (2017) and Venkitachalam and Busch (2012). This thesis pushes against the trend in tacit knowledge research by contributing new knowledge to field.

2.3.3 Definition of tacit knowledge

A literature search of the definition of tacit knowledge reveals similarities tempered by explanatory differences. Polanyi (1958, 1966), the scholar recognized for defining tacit knowledge, describes it as personal knowledge, embedded in personal experience, context related, based on awareness, and involving personal factors such as beliefs, perspectives, instincts, and values. His formulation is the foundation of philosophical discussions on tacit knowledge with the phrase: “We can know more than we can tell” (Polanyi, 1966, p. 4). Alwis, Hartmann and Seidler-De Alwis (2003, p. 134) state that tacit knowledge is personal knowledge, rooted in actions, procedures, commitments, and emotions thus hard to codify. It is the unconscious exotic form of knowledge. Gascoigne´s (2013) understanding of tacit knowledge is as follows: Tacit knowledge is context-dependent, conceptually structured, untellable, and practical. Gourlay (2003, 2004) perceived tacit knowledge as personal, experience based, contextualised, known and unknown to the holder, problematic to articulate, but capable of becoming explicit knowledge and the other way around. Nonaka and Konno (1998, p. 42) highlight that tacit knowledge is personal knowledge based on experience and ideals, deeply rooted in an individual’s actions and emotions, and difficult to express to others. It comes very close to the definition of tacit knowledge from Saint-Onge (1996) who emphasized that tacit knowledge contains beliefs, values, perspectives and intuition formed from experience. Fleck (1996) describes tacit knowledge as a subtle level of understanding, hard to verbalise, a trained recognition and perception, and specifically a good feeling for the technology. Crauise O′Brien (1995, p. 114) defined tacit knowledge as implicit, procedural, uncodified and embodied in person. Sternberg *et al.* (2000) added to the different interpretations the following characteristics of tacit knowledge: it is generated with little or no environmental support; it is procedurally and practically useful.

Table 1 below completes the picture of different definitions of tacit knowledge by delivering an overview of the most cited definitions of tacit knowledge in literature:

Table 1: Overview of most-cited definitions of tacit knowledge

Source	Characteristics of tacit knowledge
Polanyi (1966)	Tacit knowledge is personal knowledge, embedded in personal experience, context-related, based on awareness, and involves personal factors such as beliefs, perspectives, instincts, and values
Crauise O'Brien (1995, p. 114)	Tacit knowledge is implicit, procedural, uncodified and embodied in person
Nonaka and Takeuchi (1995, p. 98)	Based on experience, know-how, learning by doing. Deeply rooted in action, embodied, and context related. Consists of mental models, beliefs and perspectives so ingrained that it is taken for granted and cannot be easily articulated.
Fleck (1996)	Level of understanding, hard to verbalise, a trained recognition and perception, and, specifically a good feeling for the technology
Saint-Onge (1996)	Tacit knowledge contains beliefs, values, perspectives and intuition formed from experience
Ford and Sterman (1997, p. 1)	"Tacit knowledge is subjective, personal, and context-specific. It is difficult to describe, examine, and use".
Brown and Duguid (1998, p. 100)	"Socially embedded knowledge that "sticks," because it is deeply rooted in practice".
Nonaka and Konno (1998, p. 42)	Personal knowledge based on experience and ideals. Deeply rooted in an individual's actions, values and emotions and difficult to express to others.
Gore and Gore (1999, p. 556)	Not easy to see or express, it is highly personal and hard to formalize; rooted in the individual's experience, attitude, values and behaviour patterns.
Zack, Rand and Wilsh (1999, p. 46)	"Tacit knowledge is subconsciously understood and applied, difficult to articulate, developed from direct experience and action".
Sternberg *et al.* (2000)	Tacit knowledge generated with little or no environmental support; it is procedurally and practically useful.
Smith (2001, p. 314)	"Tacit knowledge – practical, action-oriented knowledge or ''know-how'' based on practice, acquired by personal experience, seldom expressed openly, often resembles intuition".
Gourlay (2003)	Personal, experience-based, contextualised, known and unknown to the holder, problematic to articulate but capable of becoming explicit knowledge and the other way around.
Haldin-Herrgard (2004, p. 14)	"Tacit knowledge is personal, but can be shared by individuals collectively, abstract but expressible in other forms than verbalization, affecting the ability to act independent of activity and competence and obtained by experience".
McAdam, Mason and McCrory (2007, p. 46)	"Tacit knowledge – knowledge-in-practice developed from direct experience and action; highly pragmatic and situation specific; subconsciously understood and applied; difficult to articulate; usually shared through interactive conversation and shared experience".
Gascoigne (2013)	Tacit knowledge is context-dependent, conceptually structured, and it is practical knowledge.
Chugh (2015, p. 128)	"Tacit knowledge can be defined as skills, ideas and experiences that people have in their minds".
Zhi *et al.* (2016, p. 135)	"People have recognized that the vast majority of the human beings' knowledge (accounting for 90% of the total amount of knowledge) is tacit knowledge that it is difficult to express, difficult to code".

Based on the existing similarities among the different definitions of tacit knowledge, a common and workable definition of tacit knowledge could be: Tacit knowledge is personal knowledge, experienced-based, practical and context dependent. Beyond these similarities, further common perceptions occur among different authors defining tacit knowledge. There is a strong tendency by the majority of the authors to refer to a practical context from which personal experience is gained and personal knowledge evolves. Gaining personal experience in different contexts seems to be a crucial element in the process of obtaining tacit knowledge. Furthermore, the review of the existing tacit knowledge descriptions highlights the difficulty of extracting tacit knowledge from its possessor as a common barrier to finer articulation of definition. The majority of the authors (Polanyi, 1966; Nonaka and Takeuchi, 1995; Fleck, 1996; Ford and Sterman, 1997; Brown and Duguid, 1998; Nonaka and Konno, 1998; Gore and Gore, 1999; Zack, Rand and Wilsh, 1999; Gourlay, 2003; Seidler-de Alwis and Hartmann, 2008; Zhi *et al.*, 2016) describe this challenge as follows: Tacit knowledge is hard to verbalise, problematic to articulate, difficult to express, untellable, embedded personal knowledge, deeply rooted in actions. Though it can be deduced from the statements that eliciting tacit knowledge is not impossible and conducting research on tacit knowledge requires overcoming this barrier of extracting tacit knowledge from its possessor.

2.3.4 Haldin-Herrgard´s definition of tacit knowledge to enable further research on tacit knowledge

Reviewing the existing definitions of tacit knowledge, it can be seen that a barrier to do research on the subject of tacit knowledge is articulated in the difficulties of extracting tacit knowledge from its possessor. Haldin-Herrgard (2004) addressed the challenge through an extensive literature review and came up with a definition using the overlapping characteristics of tacit knowledge that most scholars agree on. These characteristics describe tacit knowledge as knowledge that is personal, abstract, difficult to express, mostly related to practicality and obtained by experience. This definition of tacit knowledge can be seen as the explicit essence of all existing definitions of tacit knowledge, but it does not address the challenge of decoding tacit knowledge as described above. This second challenge was handled by Haldin-Herrgard (2004, p. 14) after conducting a study on tacit knowledge. This study tested a method developed by Haldin-Herrgard (2003) using subtypes of tacit knowledge to identify and map tacit knowledge in an organisation. These subtypes of tacit knowledge are verbal and written artefacts used by scholars talking or writing about tacit knowledge. Haldin-Herrgard (2003) named these subtypes, “epitomes of tacit knowledge” (ETK). According to Haldin-Herrgard (2004), “epitomes of tacit knowledge” extend the existing explicit definition of tacit knowledge, to a more comprehensive image of the tacit dimension of knowing. The results of the study, using these “epitomes of tacit knowledge” as the core element of the method extends the definition of tacit knowledge to: “Tacit knowledge is personal, but can be shared by individuals

collectively, abstract but expressible in other forms than verbalization, affecting the ability to act independent of activity and competence and obtained by experience" Haldin-Herrgard (2004, p. 14).

This extension of the definition of tacit knowledge faces the difficulties of characterising tacit knowledge (possibility of abstraction and articulation, implicitness and individuality) highlighted in literature, which leads to the possibility of further research by breaking down mental barriers to investigating tacit knowledge (Haldin-Herrgard, 2004). Haldin-Herrgard (2004) extracts the most common characteristics of the definitions of tacit knowledge in the existing literature and creates a core definition. Haldin-Herrgard (2004) then readjusts this core definition based on the results of her subsequent study delivering evidence that the identified subtypes ETK can be used to gain deeper access to the tacit dimension of knowledge. Haldin-Herrgard´s (2004) approach creates a comprehensive definition of tacit knowledge and the possibility to access the hidden world of tacit knowledge. This approach enables mapping tacit knowledge in an organisation in the form of ETK (Haldin-Herrgard, 2003). It is not the goal of this thesis to validate a completely new approach of defining tacit knowledge; this thesis employs the Haldin-Herrgard (2004) definition of tacit knowledge and the Haldin-Herrgard (2003) theoretical framework called epitomes of tacit knowledge (ETK) to refer to and to reveal the use of tacit knowledge in the context of the PDD.

2.4 The role of tacit knowledge

Building on Haldin-Herrgard´s (2003) epitomes of tacit knowledge and Haldin-Herrgard´s (2004) framework, it seems possible to investigate the role of tacit knowledge specific to an organisation and its departments. The importance of the role of tacit knowledge in organisations has risen slowly to recognition (Fleck, 1996; Howells, 1996; Sveiby, 1997). The ISO 9001 / 2015 quality management standard has recognized the role of experienced-based knowledge in enterprises, which means tacit knowledge is becoming popular (Fry, 2015). ISO 9001, applied as the standard for quality management systems in many different types of organisations is a continually updated standard for processes and organisations. The fact that recommendations for managing tacit knowledge are added to the ISO 9001 / 2015 leads to the impression that the International Organization for Standardization (ISO) has identified it as an essential factor in business management.

Expanding the view on the role of tacit knowledge in an organisation from the ISO to the view of different authors in the field of tacit knowledge research demonstrates that there are still contested perceptions to the role of tacit knowledge in an organisation. Nelson and Winter (1982) interpret the role of tacit knowledge held by individual actors in an organisation as the type of knowledge which is essential to understanding organisational routines and as an ability essential for performing in an organisation. Grant (1996, p.3) "identifies knowing how with tacit

knowledge." Knowledge as idiosyncratic knowledge and, especially, tacit knowledge is the most strategically significant resource in an organisation (Grant, 1996). Nonaka and Takeuchi (1995) indicate that tacit knowledge is a crucial strategic resource of an organisation and the most sustainable foundation of competitiveness for an enterprise and its organisation and all its activities. It is in an organisation the source of the entirety of knowledge and innovative ideas (Nonaka, 1991). Sternberg *et al.* (1995, p. 916) define tacit knowledge as uniquely important for performance in real-world activities. Kikoski and Kikoski (2004) perceive the uniqueness of tacit knowledge as a characteristic which by its sharing helps to achieve the organisation´s objectives. An increasing wealth of tacit knowledge to solve problems and to achieve goals will generate a competitive advantage (Smith, 2001, p. 319). Baumard (1999) contends that tacit knowledge in the organisation is often crucial for business success in times of uncertainty, rapid change, and turbulence. It is a key factor for decision making and navigation in a field of complex situations. Tacit knowledge facilitates the ability to cope with new situations, to adopt to new circumstances within changing conditions, especially because it is highly dynamic and enables subjects to react fast (Sternberg *et al.*, 1999). A spot-on description of the essential characteristic of tacit knowledge in the professional context emerges from Brown and Duguid (1998, p. 91) stating that tacit knowledge or know-how is the ability to put know-what into practice. Haldin-Herrgard (2003) perceives tacit knowledge as an efficient strategic asset in decision, production, and service management, promoting high quality standards and leading to a competitive advantage for an enterprise. This view coincides with the position of Jafari, Akhavan and Nourizadeh (2013) who state that tacit knowledge is crucial for organisational performance improvements that generate competitive advantage for the enterprise. Alwis, Hartmann and Seidler-De Alwis (2003, p. 133) add that a competitive advantage of tacit knowledge lies in its nature as a possible source of potential and opportunities in discovery and creativity within innovation processes. Edmondson *et al.* (2003) perceive tacit knowledge as essential for performance improvements and as closely related to efficient technology implementation. Gertler (2003, pp. 78–80) goes a step further by asserting that the innovativeness of a firm and the quality of the firm´s product as well its related production processes and modes of organisations are based, to a large extent, on the firm´s tacit knowledge. Spender (1996) expresses it negatively, referring to a loss of a firm´s tacit knowledge as precursor to strategic crisis for the enterprise. Nakano, Muniz and Dias Batista (2013, p. 290) categorize tacit knowledge as the key resource of a company which is focused on efficient manufacturing processes. Chen and Mohamed (2010, p. 230) link tacit knowledge management with helping an organisation to achieve its objectives

Interpreting theses different definitions, it can be summarised that tacit knowledge is seen as a key factor for business success and an essential element for competent, efficient and sustainable performance (Nelson and Winter, 1982; Sternberg *et al.*, 1995; Spender, 1996;

Baumard, 1999; Gore and Gore, 1999; Jafari, Akhavan and Nourizadeh, 2013). Furthermore, tacit knowledge is recognized as a leading ability in decision making processes and a strategically competitive advantage for an organisation (Grant, 1996b; Smith, 2001; Haldin-Herrgard, 2003). An enabler to react quickly and dynamically to new situations in changing conditions, it is the key ability to know how to put explicit knowledge into practice (Brown and Duguid, 1998; Gertler, 2003).

In contrast, Farrell (2003) and Hager (2000, pp. 286–288) see the function of tacit knowledge as an ambiguous concept for renaming an upcoming problem as tacit knowledge to avoid any further investigation or actions to understand or to solve the problem. Torff (1999), citing the fact that tacit knowledge arises from experience, states that tacit knowledge could also hinder radical changes. The explanation behind that statement is grounded in the theory that existing norms are created out of tacit knowledge, which is based on experience, and make it no longer relevant to establishing new knowledge. The existing knowledge is understood as fixed knowledge. This perspective seems to be reinforced by Johannessen *et al.* (2001, p.11) “that tacit knowledge can be a key barrier to innovation. This is because tacit knowledge is usually part of a long-term learning process in a specific context, being embodied in the structure of thinking, the way of thinking, and therefore its function as a conservative element in relation to innovation”. Such an interpretation emerges from the position that tacit knowledge is tradition-related and that traditions are not be easily changed. Fleck (1996, p. 119) describes tacit knowledge as: “most crucial in restricting the social distribution of knowledge and has been widely identified as a major constraint on the diffusion of both science and technology”.

According to this school of thought, tacit knowledge is a crucial barrier to changes and innovation because it is a conservative force that comes out of traditions whose core aim is that of sticking to already established routines and practices (Johannessen, Olaisen and Olsen, 2001; Farrell, 2003). It is viewed as a paralysing phenomenon in organisations and the professional context (Fleck, 1996). The table 2 below displays the different positions from different authors with respect to the role of tacit knowledge sorted by date.

Table 2: Different perceptions of the role of tacit knowledge in organisations

Source	Role / potential of tacit knowledge
Polanyi (1958)	Essentially for living.
Nelson and Winter (1982)	Held by individual actors in an organisation, as the type of knowledge which is essential to understand organisational routines and as an ability for performing in an organisation.
Nonaka and Takeuchi (1995)	Tacit knowledge is a crucial strategic resource of an organisation and the most sustainable foundation of competitiveness for an enterprise and its organisation and all its activities.
Fleck (1996, p. 119)	"Most crucial in restricting the social distribution of knowledge and has been widely identified as a major constraint on the diffusion of both science and technology".
Grant (1996)	Knowledge, idiosyncratic knowledge, and especially tacit knowledge is the most strategically significant resource in an organisation - Also most of the knowledge which is relevant to production is tacit knowledge. Required for decision making.
Spender (1996)	A strategy for business success.
Brown and Duguid (1998, p. 91)	Tacit knowledge or know-how is the ability to put know what into practice.
Baumard (1999)	Tacit knowledge in an organisation is often crucial for business success. Especially hard times in an enterprise can be managed by relying on the use of tacit knowledge. Key factor for decision making and navigation in a field of complex situations. Crucial for learning processes. -
Gore and Gore (1999, p. 556)	"This knowledge is equally important to the successful operation of an organization… Undoubtedly, such tacit knowledge is a key to knowledge creation".
Torff (1999)	A barrier for radical changes.
Hager, (2000, pp. 286–288)	Tacit knowledge is an ambiguous concept for renaming an upcoming problem as tacit knowledge to avoid any further investigation or actions to understand or to solve the problem
Ambrosini and Bowman (2001, p. 811)	"Occupies a central role in the development of competitive advantage. Tacit knowledge lies at the base of sustainable competitive advantage…..resource that allows a firm to perform better than its competitors".
Johannessen, Olaisen and Olsen (2001, p. 11)	"Tradition related - A key barrier to innovation. This is because tacit knowledge is usually part of a long-term learning process in a specific context, being embodied in the structure of thinking, the way of thinking, and therefore its function as a conservative element in relation to innovation. An interpretation created out of the position that tacit knowledge is tradition-related and traditions won´t be easily changed. But tacit knowledge is also essential in creating sustainable competitive advantages. Tacit knowledge is a sort of organizational immune system hindering imitation from other social systems. The function of tacit knowledge is then both conservative, i.e. stabilizing the system, and acting as an imitation guard. Also continuous improvements are enhanced by tacit knowledge".

Source	Role / potential of tacit knowledge
Gertler, (2003, pp. 78–80)	"An essential complement of explicit knowledge, in the sense it supports the acquisition and transmission of explicit knowledge….The quality and the innovativeness of a firm´s product as well its production processes, modes of organisation and procedures, depend to a very large extent on their tacit knowledge content".
Edmondson *et al. (*2003)	Tacit knowledge is needed for performance improvement. Related to successful implementation of new technologies.
Farrell (2003)	Concept for renaming an upcoming problem to avoid any further investigation or actions to understand or to solve the problem.
Haldin-Herrgard (2003)	An efficient strategy in decision, production and service management to reach high quality which leads to a competitive advantage for an enterprise.
Kikoski and Kikoski (2004)	To achieve the organisation´s aim and objectives.
Seidler-de Alwis and Hartmann (2008, p. 133)	"Tacit knowledge can be the source of a huge range of opportunities and potentials that constitute discovery and creativity. A key lever for achieving innovation success".
Chen and Mohamed (2010, p. 230)	Tacit knowledge management helps an organisation to achieve the organisational objectives.
Jafari, Akhavan and Nourizadeh (2013)	Tacit knowledge is crucial for organisational performance improvements, which generates a competitive advantage for the enterprise
Nakano, Muniz and Dias Batista (2013, p. 290)	Tacit knowledge is the key resource of a company which is elementary for efficient manufacturing processes

Looking above at the key schools of tacit knowledge helps to understand why there are contested positions in the perception of the role of tacit knowledge in an organisation. The authors Nonaka and Takeuchi (1995), Spender (1996), Brown and Duguid (1998), Baumard, (1999), Sternberg *et al.* (1999), Smith (2001), Alwis, Hartmann and Seidler-De Alwis (2003), Edmondson *et al.* (2003), Gertler (2003), Haldin-Herrgard (2003), Kikoski and Kikoski (2004), Chen and Mohamed (2010), Jafari, Akhavan and Nourizadeh (2013) and Nakano, Muniz and Dias Batista (2013) who define tacit knowledge as a key success factor for business and organisations all belong to the field of Knowledge management, Organisation management, Business management, and Psychology.

While authors such as Torff (1999), Hager (2000) and Farrell (2003) who challenge the value of tacit knowledge in the professional context and argue that tacit knowledge is a paralysing

phenomenon and a crucial barrier for new knowledge, innovations, and changes belong to the fields of Education, Teaching, and Information-Technology. The authors Fleck (1996), Johannessen, Olaisen and Olsen (2001) are not from these domains but their reviewed papers have been published in IT and Technology journals and are with this related to the above mentioned domains.

Authors writing in the management and business domains could have an interest in promoting the benefit of consciously handling tacit knowledge to convert this into business success. Therein lies a justification for buying their books, doing research in the field of tacit knowledge, promoting experts and much more beneficial items

Authors in the field of education, teaching, and information technology, as well as authors who are publishing in journals of these domains might be closer to the barriers of tacit knowledge. The view that tacit knowledge is usually seen as a long-term learning process in a specific context, tradition related, and strongly embedded in a person might lead to the position that tacit knowledge stands in opposition to the overall aims of teaching, education and IT (operationalising all knowledge). The “service” feature related to explicit knowledge (e.g. knowledge transfer, knowledge management), which these authors mainly deal with, is not a dominant concept in the characteristics of tacit knowledge. When challenged to do so by their readership who have discovered such ideas on their own, these authors would likely present - or represent - tacit knowledge as a key success factor in organisations and as a long term-learning process embedded in a person. In so doing, the “service” the domains of teaching and education deals with could be challenged and changed by their customers. This will possibly create tension between the academic sections of teaching and education and the people who are interested in it.

Both positions, with respect to the defined function of tacit knowledge in the professional context, are possibly using the power of their academic domains to underscore and transmit their perception of the function of tacit knowledge. The above-constructed reasons are not proven theories but the similarity of the authors within those different and contested positions delivering a strongly suspicious hint of power and politics within the academic interpretation of the function of tacit knowledge in the professional context.

This finding sensitised this researcher-author to the power and politics, proceeding from the different domains, with respect to the positions of different authors on the characteristics of tacit knowledge. The discussion above ensures that this research draws a holistic and balanced picture on the role of tacit knowledge by having a homogenous mix of relevant literature out of different domains in the field of tacit knowledge to avoid any kind of unintentional impact on the results of this study caused by the mentioned power and politics from different domains.

Summarized it can be stated that authors of the management and business domains perceive the role of tacit knowledge in organisations from supportive to crucial with respect to business success. The authors out of the domain of education, teaching, and information technology, as well as authors who are publishing in journals of these domains might be closer to the barriers of tacit knowledge.

This research focuses on revealing the role of tacit knowledge in the development department of a multinational car manufacturer by exploring how tacit knowledge is used by knowledge workers to achieve what aim. Since this research is conducted in a high intensive business sector in which successful management is crucial for business success and it is evident that the role of tacit knowledge in such a field is crucial to achieve organisational aims, this study is positioned in the management and business schools of thought.

2.5 Different dimensions of tacit knowledge

The statement from Nonaka and Takeuchi (1995) on the role of tacit knowledge in an organisation, that tacit knowledge is a crucial strategic resource and a sustainable foundation of competitiveness for all activities of an organisation, shows that the use of tacit knowledge in an organisation is related to different dimensions. The literature classifies tacit knowledge mainly into two dimensions. The most common distinction is between a technical and a cognitive dimension. The technical dimension describes the connection between expertise, information and know-how which can be used in specific situations (Nonaka and Takeuchi, 1995; Gore and Gore, 1999; Alavi and Leidner, 2001; Smith, 2001). The cognitive dimension is seen in personal perspectives, beliefs, and mental models, and draws upon a person's perception of reality and the notion of the future (Nonaka and Takeuchi, 1995; Sternberg, 1997; Small and Sage, 2005). Gore and Gore (1999) emphasize that the cognitive dimension is deeply rooted in personality and taken for granted. While this dimension of tacit knowledge has an impact of a person´s perception its codification is challenging.

A further classification of tacit knowledge by Kikoski and Kikoski (2004) splits tacit knowledge into fast and slow types. The fast type performs on implicit cognitive processes. Kikoski and Kikoski (2004) refer here to the survival instinct of an animal which is based on deeply-rooted reflexes. This example demonstrates that this type of tacit knowledge is, according to Kikoski and Kikoski (2004), more related to animal nature. The slow type of tacit knowledge is unique to human nature and describes paradigm changes. Fast tacit knowledge is more physical in contrast to slow tacit knowledge which is more mental and intellectual.

Ambrosini and Bowman (2001) classify tacit knowledge according to the degree of tacitness. The scope is from low, which describes explicit skills, easily observed from the person himself or from outside, to high, which is related to deeply ingrained tacit skills. This approach shares

similarities with another approach of classifying tacit knowledge. The other approach describes the classification of tacit knowledge, by differentiating tacit knowledge according to its level of abstraction, the actors involved, and the activities affected (Haldin-Herrgard, 2004). Taxonomies developed based on a literature review by Haldin-Herrgard (2003) reveal that the existing dimensions of tacit knowledge are too narrow to describe all dimensions of tacit knowledge. The level of abstraction is, according to Haldin-Herrgard (2004), a continuum where one end is abstract and the other end is concrete. Haldin-Herrgard (2004) extended this notion of classification by the variable of actors involved, a mean of grouping tacit knowledge according to the context where it appears and is used. The granularity of this grouping was increased by adding a further variable of tacit knowledge, the activities affected. Here, division by mental, sensuous, social and practical forms of tacit knowledge is added (Haldin-Herrgard, 2004). Using the Haldin-Herrgard (2004) approach of classifying the use of tacit knowledge into activities affected from tacit knowledge helps the researcher in this study to increase granularity in the results of this thesis with respect to the diffusion of the use of tacit knowledge in the PDD (Appendix 2: Overview of classified ETK according to the field of activities). This increase in granularity allows concretisation of the statement from Nonaka and Takeuchi (1995) of all activities affected by the use of tacit knowledge in an organisation into specific activities affected in an organisation. Identfying concrete fields of activities for the use of tacit knowledge in the PDD contributes further depth to the results of this thesis.

2.6 Employing ETK conceptual ideas in this thesis to elicit tacit knowledge application in the PDD

Haldin-Herrgard (2003) maps out tacit knowledge by identifying subtypes of tacit knowledge. The subtypes Haldin-Herrgard (2003) identified are embodied in a vocabulary used by scholars (see for example: Polanyi (1966); Nonaka and Konno (1998); Gourlay (2004); Seidler-de Alwis and Hartmann (2008); Sternberg *et al.* (2000)) to articulate and understand the abstraction of the tacit dimension of knowledge. Even as scholars discuss their projects or collect information on tacit knowledge, these specific terms are used.

As a result of an extended literature research on the topic of tacit knowledge, Haldin-Herrgard (2003) created a language tool-box to refer to tacit knowledge artefacts called “epitomes of tacit knowledge (ETK)”. In total, Haldin-Herrgard (2003) identified 149 ETK which were reduced to 92 ETK during a verification study (see Appendix 1). Though the Haldin-Herrgard (2003) approach has not yet received broad attention and has limited validity testing in different contexts, the identification of intersections between an extended number of vocabulary used among acknowledged scholars and researchers indicates that the Haldin-Herrgard (2003) conceptual framework is appropriate for further research on tacit knowledge.

This thesis builds on the conceptual idea of ETK, developed from Haldin-Herrgard (2003) to overcome the most crucial barrier in research on tacit knowledge, the possibility of eliciting tacit knowledge (Gore and Gore, 1999; Ambrosini and Bowman, 2001). Using this conceptual idea of ETK in the first step of data gathering in this sequential research, enables the researcher to identify and locate the use of tacit knowledge by knowledge workers in the PDD. Based on the finding that there is no common definition of tacit knowledge in current science, this thesis used the conceptual framework from Haldin-Herrgard (2003) and identifies the use of tacit knowledge in the form of ETK. As previously explained, these ETK are concepts that in any context facilitate the verbalization of the use of tacit knowledge (Haldin-Herrgard, 2003). Existing organisational secondary data, in this case internal job advertisements, are reviewed for the use of ETK in this quantitative first research step. The diffusions of ETK by investigating the frequency of ETK usage and the type of ETK used within these job advertisements for different positions draws a picture of tacit knowledge usage in the form of ETK by knowledge workers in the PDD. The field for further investigation for research on tacit knowledge based on these first results can be narrowed to knowledge workers with the highest use of tacit knowledge and to specific tacit knowledge in the form of ETK frequently used to perform successfully in these the PDD positions. Therefore, in face of unusually high retirement numbers, these workers are the most critical resources in the PDD with respect to organisational knowledge loss.

In screening of organisational data for examples of tacit knowledge usage, application of ETK is understood as enabler of identification and extraction. However Haldin-Herrgard´s (2003) ETK conceptual framework has its limitations in further exploring the phenomenon of tacit knowledge. Because tacit knowledge is deeply ingrained context-related knowledge and ETK are located on the surface of the phenomenon tacit knowledge, the deeper meaning of tacit knowledge application behind a specific ETK cannot be deduced from the ETK itself (Sternberg, 1997). Tacit knowledge must be explored in the context of application linked to the possessor, which is supported by a multitude of studies on tacit knowledge employing different interview techniques to explore the phenomenon tacit knowledge (e.g.: Sternberg and Horvath, 1999; Ambrosini and Bowman, 2001; Haldin-Herrgard, 2003; Garcia-Perez and Mitra, 2007; Goffin and Koners, 2011; Jafari, Akhavan and Nourizadeh, 2013; Kothari *et al.*, 2011; Venkitachalam and Busch, 2012). To compensate for this limitation and to generate new knowledge on the meaning behind the application of tacit knowledge in this organisation, research step two in this thesis is about the conduction of semi-structured interviews with PDD knowledge workers. Based on the characteristics of tacit knowledge (embodied in a person and hard to verbalize), interviews are seen as an appropriate technique to facilitate explanation and discussion on the use of tacit knowledge (Haldin-Herrgard, 2003). In this qualitative step of data gathering, the ETK which frequently appeared in the reviewed job advertisements build

the central themes within the interview questions. By concentrating on tacit knowledge in the form of ETK which frequently appear in these positions, the research focus is on the most critical variables of tacit knowledge usage in the PDD. This thesis extends and carries forward the study from Haldin-Herrgard (2003) as follows:

The use of internal job advertisements, which as organisational data, addresses the request made by Kabir (2013) for new knowledge on identifying tacit knowledge resources by reviewing available organisational data. An approach to identify tacit knowledge in organisational data is not available in the literature in research on tacit knowledge within the automotive sector. According to Kabir (2013), an organisation has to concentrate on making tacit knowledge available. Kabir (2013) refers here to an analysis of the massive pool of data available in an organisation. The approach to identify tacit knowledge in existing organisational data is viewed by the author of this thesis as a potential improvement to the approach from Haldin-Herrgard (2003). Haldin-Herrgard (2003) conducted her study in a small company. Data gathering and analysis was made more manageable because of this small organisation. Because of the limited number of employees to be interviewed locating tacit knowledge in such a small organisation is not that time and cost intensive. This is not the case in a big multinational company. Intervieweing all employees in a big organisation to identify and locate the use of tacit knowledge in this organsation would be unrealistic with respect to time and cost. Using existing organisational data to identify and locate tacit knowledge usage in this orgsanisation will reduce time consumption and costs.

Applying the theoretical concept of ETK in research on tacit knowledge, this study carries the work of Haldin-Herrgard (2003) forward into the automotive sector and broadens the field with respect to a request for research on tacit knowledge by McAdam, Mason and McCrory (2007). McAdam, Mason and McCrory (2007) claim that there is a need for research on the potential to conceptualize epitomes for managing tacit knowledge in an organisation. Using ETK to get access to the hidden world of tacit knowledge in the PDD by applying the theoretical concept to this context delivers a new application of employing ETK for research on tacit knowledge. The application of the ETK concept answers the question on the potential of using ETK in managing tacit knowledge in an organisation.

Furthermore, this thesis extends the study from Haldin-Herrgard (2003) to an approach which can help enterprises to assess the risk of possible knowledge loss in case of employee retirement as demanded from Sumbal *et al.* (2017) and Holtshouse, (2010). Haldin-Herrgard (2003) used a holistic view on how tacit knowledge is diffused in a small organisation, while this thesis goes beyond the identification and location of tacit knowledge. This study seeks to explore the “how” and “why” of tacit knowledge use that is essential and critical to the PDD of a multinational automobile manufacturer. To explore the how and why of usage of specific tacit

knowledge frequently by knowledge workers in the PDD helps to contextualize tacit knowledge usage in organisational activities and increases the understanding of its effect in the organisation.

2.7 Research on tacit knowledge related to the automotive sector

The literature research reveals that a potential reason for the lack of progress in tacit knowledge research in the last years is the fact that work on identifying tacit knowledge tend to be very domain specific. There are also differences in the research outcomes among different contexts and countries due to the individual character and cultural relations of tacit knowledge (Gourlay, 2003, 2004; Gascoigne, 2013). Concentrating on research on tacit knowledge in the automotive sector, only a few studies were found. Starting with Nonaka and Takeuchi (1995) whose organisational knowledge creation theory led to the SECI model, included automotive sector managers from Honda and Mazda in their investigation of tacit knowledge creation and sharing. Jafari, Akhavan and Nourizadeh, (2013) conducted an empirical study in the Iranian automotive sector to classify employees based on their individual tacit knowledge. Jafari, Akhavan and Nourizadeh, (2013) explicitly request further research on tacit knowledge in the automotive sector. Saad, Grundstein and Rosenthal-Sabroux (2003) touched on tacit knowledge in their study in the automotive sector as well, by referring to company's crucial knowledge. The aim was to locate crucial knowledge to improve the quality of a corporate memory in a design project. Dyer´s and Nobeoka´s (2000) study explains the productivity advantages of Toyota and their suppliers by examining Toyota´s knowledge sharing ability (including tacit knowledge) within their network.

Extending the search scope in the literature review from automotive section only to suppliers to automotive manufacturers, two additional studies touching on tacit knowledge were found. Flanagan, Eckert and Clarkson (2007) conducted a case study at a diesel engine company to investigate how confidence models could be used to externalize tacit overview knowledge to support design teams. Sliwa and Patalas-Maliszewska (2015) created a model for converting tacit knowledge into explicit knowledge in the R&D department of a manufacturer performing as a part supplier in the automotive segment. Since tacit knowledge is context related the results of the existing studies conducted in the automotive sector are not suitable for general usage in the domain of tacit knowledge, which limits also the strategic usage of tacit knowledge (Polanyi, 1966; Johannessen, Olaisen and Olsen, 2001; Gourlay, 2006; Garcia-Perez and Mitra, 2007; Insch, McIntyre and Dawley, 2008; Zhi *et al.*, 2016). Hence, to stimulate progress in research on tacit knowledge and to reduce uncertainty in understanding it, additional research on tacit knowledge is necessary. In a constantly changing world ongoing research is essential. Changing perspectives, approaches or strategies in research on a phenomenon situated in a specific context can lead to a new understanding of the phenomenon in a general

sense. This thesis contributes to the body of knowledge the understanding of tacit knowledge by situating this research in the context of a multinational automotive manufacturer´s product development department.

2.8 Summary of identified gaps in research on tacit knowledge

The context dependence characteristic of tacit knowledge limits the application of research results to other contexts. Research on tacit knowledge in the automotive sector has been identified as significantly underrepresented via a self-evident literature gap on tacit knowledge in the automotive sector. As a result of the literature review, the author heeds the request of Jafari, Akhavan and Nourizadeh, (2013) to contribute further scholarly work on tacit knowledge usage in the automotive sector and simultaneously answering open calls for future research on tacit knowledge made by Kabir (2013), McAdam, Mason and McCrory (2007); Holtshouse (2010); Sumbal *et al.* (2017). Kabir (2013) requested further research on knowledge that enables an organisation to identify tacit knowledge resources in organisational data. McAdam, Mason and McCrory (2007) encourage further research to close the gap in knowledge on the potential of using epitome–based approaches for research on tacit knowledge. Sumbal *et al.* (2017) and Holtshouse (2010) call for relevant research on an approach to assess the risk of possible knowledge loss in an organisation because of an increase in employee turnover.

Chapter 3: Research methodology

3.1 Context and background of the researcher

Because the researcher is part of this organisation, the context and the background of the researcher are significant in this research and have an impact on the research itself. For the sake of transparency and to help the reader to create a holistic understanding of the interdependencies between the researcher and the context of this research, the background of the researcher is outlined. The author of this thesis and leader of this research project has been employed for twenty-three years in the enterprise where the research has been conducted. His father worked more than forty years for the same enterprise before his retirement. The author’s career started with an apprenticeship as a mechanic in this enterprise. Having his apprenticeship period shortened by one year, because of excellent grades, the company offered the author the opportunity to complete his university entrance diploma by releasing him from his work with a guarantee of a reappointment. After successful completion of the diploma and civilian service, the author resumed working at the enterprise as a mechanic in the engine production area in which he was responsible for production quality and maintenance. Later on, he was given the opportunity to be apprenticed to a test driver role. In this position he had his first contact to the product development section. After a short time as

a test driver, he transitioned into the position of specialist for experimental constructions in the product development group with a focus on transmission development. In this role, the author gained experience in the field of experimental testing. At the same time, he began a part time B.A. program in Business Management. After degree completion, he moved into the position of a test and development planer. In this role, he planned and coordinated the building of prototypes and the testing of these prototype across different functional teams in Europe. Throughout the prototype planning period the author concurrently completes an M.A. in Business Management. Later on, he moved into specialist position for prototype budget and resource estimating in Europe for the product development section of the enterprise, which is still his current role. The brief overview of the author's different responsibilities over the last twenty-three years displays how deeply the researcher is embedded in this organisation and describes his holistic amount of experience collected in this time frame. It also describes his commitment to this enterprise. The next section explains why the role of this research is special and how this role might impact this research.

3.2 Employee as researcher

In this special context, the researcher, as part of the organisation in which he is doing research, becomes an insider researcher (Bonner and Tolhurst, 2002; Coghlan, 2003; Breen, 2007; Saunders, Lewis and Thornhill, 2016). Breen (2007), Bonner and Tolhurst (2002), Coghlan (2003), Saunders, Lewis and Thornhill, (2016) and a variety of other authors label the type of researcher who is a member of the group or part of the organisation in which he is doing research an insider researcher.

The role of an insider researcher is unique; therefore, it is necessary to highlight this researcher characteristic in this context. An insider researcher, as a member of an organisation, can provide insights into special groups, hidden structures, connections and organisations, which would not otherwise be accessible to an outsider. Besides the useful advantages an insider researcher has compared to an outside researcher e.g. familiarity with the culture of the enterprise, insider knowledge, or a good functional network , an insider researcher faces also special challenges, e.g. role duality or ethical issues (DeLyser, 2001; Coghlan, 2003; Breen, 2007; Bryman and Bell, 2015; Saunders, Lewis and Thornhill, 2016). The researcher is aware of the challenges the role of insider researcher presents. Mercer (2007) foresees power relation issues of an insider researcher only when the researcher is in a higher-ranked position over the interviewee. The researcher of this project is in a unique position as a specialist with no ranking that would make him more senior to the participant. Therefore, power-related issues should not occur. Potential ethical issues have been averted by working together with the Ethical Committee of the University and Human Resources in the PDD to review policies and

address any concerns of either entity. Hence the advantages of this position as an insider researcher in this context should help efficiently achieve deep insights.

3.3 The philosophical paradigm

There is no recommendation of a definitive philosophical paradigm that supports eliciting tacit knowledge. The literature review points to the positivist stance in research on tacit knowledge, primarily accomplished by large scale surveys with an extensive use of Likert scales (Lin, 2007; Insch, McIntyre and Dawley, 2008; Borges, 2012; Tsai, 2014; McIver and Wang, 2016). These studies are often based on a design initially used in research on explicit knowledge. While the design for explicit knowledge works, the same design in tacit knowledge research might ignore characteristic indicators of its presence: personal knowledge; based on awareness; embedded in personal experience; context related; involving factors such as beliefs; perspectives, instincts and values; not easy to verbalize or to store in databases (Gourlay, 2003, 2004; Polanyi, 2009; Gascoigne, 2013). Therefore, studies which are using a positivist approach may lack research validity, making it questionable if new theories on tacit knowledge were properly tested (Buunk, Hall and Smith, 2016, p. 3).

Polanyi (1966) saw the human body as an ultimate sensory interface to reality, explicitly rejected the positivist philosophy because of the characteristics of tacit knowledge. The characteristics of positivist ontological-reality is independent from social actors (Saunders, Lewis and Thornhill, 2016) - and positivist epistemology-reality consists of what is available to the senses (that is what can be seen, touched, smelt, etc.) (Gray, 2009) – would render tacit knowledge non-existent, therefore, not researchable. Thus, a valid and strong argument emerges against the adoption of a positivist philosophy in research on tacit knowledge.

The researcher's personal experience in the professional context with the phenomenon being researched in this thesis, the use of tacit business knowledge, leads to biased and value-laden research; the researcher is not independent and does not maintain an objective position. This circumstance linked to the insider role of the project researcher was taken into consideration during the decision process for determining the philosophical stance the researcher engaged in this thesis. The positivist philosophy explicitly rejects a value-laden position. The belief here is that the research is value free and the researcher is independent. Summarizing the above-listed findings and arguments, it can be stated that the straight positivist philosophy does not fit the variables of the research project in this research.

On the other hand, there are studies on tacit knowledge in the current literature that take an interpretivist approach (Neve, 2003; Puusa and Eerikäinen, 2010; Kothari *et al.*, 2012; Whyte and Classen, 2012). These qualitative studies are conducted through interviews, surveys, observation of focus groups, and simple case study settings. The criticism here is that those

studies tend to lack rigor in the results and deliver only limited, though detailed, understanding on the tacit knowledge phenomenon without reliable generalizable applicable models (Myers, 2000; Yin, 2014).

The above highlighted philosophical positions are located on ends of a philosophical continuum. The author of this thesis contends that neither extreme of the above-described philosophical positions properly fits the characteristics of tacit knowledge. The personal philosophical position of the researcher leans slightly toward the positivist end of the continuum. The researcher of this thesis labels this position “critical realism”, which seems to be the most appropriate philosophical stance for research on tacit knowledge. Critical realism builds a synthesis in the philosophical continuum between the positivism and the interpretivism ends. A critical realists beliefs is that there is a measurable external reality which provides credible data and facts, but achieving measures can be difficult (Saunders, Lewis and Thornhill, 2016; Gray, 2009). A critical attribute of the phenomenon tacit knowledge lies in the form of tacit knowledge appearance; it cannot be directly detected or identified (Polanyi, 1966). Tacit knowledge appears in different forms of representation, which means the use of tacit knowledge can be assumed to underlie skills of a person, the quick decision of a manager, the creativity of a designer, or the ability of an employee to efficiently perform. Hence, for the identification of tacit knowledge, a researcher must recognize that tacit knowledge is not an obvious phenomenon. The researcher’s perceived reality has a hidden truth, the use of tacit knowledge. In this research ETK used in job advertisements help to gain access to the hidden truth elements in the realm of tacit knowledge. There is no direct image of tacit knowledge available to the senses of a researcher observing tacit knowledge. It appears only as a representation and it needs to be elicited in the context in which it appears. The appearing representations of tacit knowledge in the real world are only indicators for its use. Such circumstances match the position of a critical realist who argues that a person can experience only sensations, not apprehending things directly, qua the phenomenon of tacit knowledge (Saunders, Lewis and Thornhill, 2007, p. 105). Ritchie and Lewis, 2012 (p.16) describe that perception of a critical realist with: There is a distinction in the perception of reality between the beliefs about the world and the way the world is. The researcher’s awareness that representations display the phenomenon tacit knowledge in the layer-by-layer removal of the cover on the phenomenon of tacit knowledge, thus generating deeper insights. The researcher shares the positivism position that acceptable knowledge can only be created through scientific approaches and settings (Bryman and Bell, 2015). This conviction guarantees the avoidance of application of improper techniques or misinterpretation of results. Hence the study conducted here endeavours to eliminate the above-highlighted limitations of the pure positivist and the pure interpretivist philosophy by doing research out of the stance of a critical realist.

3.4 Flexible research design and an inductive approach

The identification of tacit knowledge in an organisation is commonly recognized as the primary challenge by authors in the field of tacit knowledge (Gore and Gore, 1999; Ambrosini and Bowman, 2001). The majority of the authors in the field define tacit knowledge as hard to verbalise, problematic to articulate, difficult to express, untellable and embedded personal knowledge, and deeply rooted in actions (Polanyi, 1966; Nonaka and Takeuchi, 1995; Fleck, 1996; Ford and Sterman, 1997; Brown and Duguid, 1998; Nonaka and Konno, 1998; Gore and Gore, 1999; Zack, Rand and Wilsh, 1999; Gourlay, 2003; Seidler-de Alwis and Hartmann, 2008; Zhi *et al.*, 2016). These frequently used attributes of tacit knowledge in the literature describe the identification of tacit knowledge as something not directly accessible. As explained above, tacit knowledge appears as a representation and is, therefore, not directly visible to the researcher. Tacit knowledge appears in an individual's education, abilities, experiences, skills, feelings, interactions, actions, creativity, and organisational behaviour (Polanyi, 1966; Fleck, 1996; Ford and Sterman, 1997; Sternberg *et al.*, 2000; Smith, 2001; Garcia-Perez and Mitra, 2007; Seidler-de Alwis and Hartmann, 2008).

Because of the challenge of identifying tacit knowledge in its multiple forms of appearance, this thesis builds research on two sequential steps. The first research step, is built on identifying and quantifying tacit knowledge usage in this organisation, which create the foundation for research step two. Research step two, the main stage of data collection, further explores the "how" and "why" of tacit knowledge use by knowledge workers in this context. Hence this sequential research requires a study design which is flexible and adapts the research focus according the findings in research step one. Whereas fixed research designs are often theory driven and all variables to investigate are known, which allows to fix the study before the main stage of data collection takes place, (Boeije, 2009), this research is not theory driven nor is the study fixed before the first research step is conducted. Based on these arguments, this thesis uses a flexible research design. Furthermore, a research approach that does not build on hypothesis testing, which requires an existing theory, but builds like this research on observations during data analysis to construct generalizations and relationships, is called an inductive approach (Gray, 2009). Therefore, this sequential research project describes the use of an inductive approach.

3.5 Research methodology

Case study methodology is used to answer the research questions in this thesis. The case study methodology is popular and often employed in business research (Eisenhardt and Graebner, 2007). Existing literature indicates that there is no nomothetic definition of a case study. A case study as research methodology is used across a variety of domains to generate

knowledge in a structured process. The case study methodology is an empirical inquiry that allows a researcher to focus on a case in a natural and holistic setting with real world-perspectives (Yin, 2014; Robson and McCartan, 2016). The majority of the authors in the field of tacit knowledge claim that the use of tacit knowledge is a key factor for business success in organisations and link tacit knowledge usage by members of an organisation to business success (Nelson and Winter, 1982; Sternberg *et al.*, 1995; Spender, 1996; Baumard, 1999; Gore and Gore, 1999; Jafari, Akhavan and Nourizadeh, 2013). Hence, a key motivation for research on tacit knowledge in the PDD is to understand the contextual relationships between social actors and their organisational environment. Yin (2014), Robson and McCartan (2016), Morris and Wood (1991) and Hartley (2004) emphasize if a context is not clearly obvious, or evident, and there is just a little understood of it, it is important to identify the relations and boundaries between the phenomenon to be explored and the context in which it appears in order to achieve an essential understanding of the phenomenon. The distinctive advantage of the case study methodology to other methodologies is the focus on contextualization between the phenomenon and its related boundaries in its natural setting, which enables this researcher to verify the impact of those relations on the usage of tacit knowledge (Robson, 2002; Creswell, 2012; Hakim, 2012; Yin, 2014). Therefore, the case study methodology helps to gain a rich and holistic understanding of the phenomenon of tacit knowledge which is not independent from social actors.

The case study methodology can be used along the continuum between positivist and the interpretivist position; can be deductive and inductive (Løkke and Sørensen, 2014). This case study will use an inductive approach seated in a critical realist philosophy. The proposed research questions are carefully verbalized by using the question words “how” and “what”. Gray (2009) and Leonard-Barton (1990) see case study as an ideal method to answer “how” and “what” questions surrounding contemporary phenomena; here the researcher does not have any kind of steering ability or control over behaviour of the participants and the phenomenon to be explored in the case study. Saunders, Lewis and Thornhill (2016) and Leonard-Barton (1990) also state that if a researcher is interested in answering questions on how, what, and why, a case study is the method of choice. Gray (2009) and Saunders, Lewis and Thornhill (2016) find the case study descriptive, but also explanatory and exploratory in research character. Gummesson (1991) and Tellis (1997) describe the explanatory and exploratory character of the case study as an opportunity for a holistic view on the phenomenon. The scientific frame of the case study supports this study in several aspects. Different angles of observation on the phenomenon of tacit knowledge within its natural setting combine with the researcher´s capacity for understanding to contextualise the research within the PDD.

Summarizing and completing the above-highlighted advantages of the case study methodology in this research: The case study methodology helps to identify and understand possible existing boundaries of unclear relations between the use of tacit knowledge and the context in which it appears (Yin, 2014). Its character supports the collection of multiple data sources and helps handle a wide range of the phenomenon-linked variables (Robson, 2002; Gray, 2009; Creswell, 2012; Hakim, 2012; Yin, 2014). The case study methodology will answer the research questions of “how”, “what”, and “why”, and its exploratory attribute supports the holistic view on the phenomenon of tacit knowledge by using different angles of observation (Leonard-Barton, 1990; Gummesson, 1991; Gray, 2009; Saunders, Lewis and Thornhill, 2016). Furthermore, case study methodology helps eliminate the limitations of a purely quantitative method by combining quantitative and qualitative approaches (Creswell, 2012; Hakim, 2012; Ritchie and Lewis, 2012). The “loose” structure of this methodology makes it possible to conform the design and data collection methods exactly to answer the formulated research questions (Meyer, 2001). Such circumstances support this sequential research approach where the second step is adjusted to the analysis of the data from research step one.

Despite all of the listed advantages, there are also disadvantages. Yin (2014), Eisenhardt (1989), Meyer (2001), Gibbert, Ruigrok and Wicki (2008), claim that a specific requirements guideline for conducting a case study does not exist. This makes the case study a more challenging approach than a survey, a quasi-experimental approach, or a grounded theory strategy. According to Meyer (2001), two factors lead to poor outcomes in case study-driven research: firstly the high variety of existing case study designs and secondly the lack of requirement guidelines which lead to poor design choices by researchers. A further disadvantage of this methodology is that a case study uses just a small number of subjects and samples, which makes it often difficult to generalize the findings of a case study (Stake, 1995; Gray, 2009; Vissak, 2010; Ritchie and Lewis, 2012; Yin, 2014; Bryman and Bell, 2015; Saunders, Lewis and Thornhill, 2016). Yin (2014) labels this methodology, with its limited use of samples, “microscopic,” but he also emphasizes that formulating concrete objectives and establishing parameters is more important than big sample sizes. Hamel, Dufour and Fortin (1993) also state that a larger sample size will not turn the multiple case study into a macroscopic study, but that the overall aim of the study should be the development of parameters which can be applied in other research projects. Case studies are frequently judged as a massive time-consuming method, with an associated risk of losing focus while managing the necessary systematic organisation of the large amount of data and the linked documentation (Yin, 2014). To avoid such pitfalls, Yin (2014) recommends a well-planned and smartly-focused case study protocol to keep the research on track and render a product integrity of the highest possible quality. The protocol represents the mental roadmap of the

researcher and helping the researcher stay focused on his research aim. It consists of an overview of the project, a description of field procedures, data collection questions and a guide for a case study report (see Appendix 11).

3.6 Contrasting two different case study designs for undertaking this research

The single case study design and the multiple case study design offer two different approaches for undertaking research in the field of tacit knowledge. Punch (2013) states that a case is hard to define, since everything can be seen as a case, but a typical case includes individuals or organisations. The case in this thesis is the usage of tacit knowledge by knowledge workers in the product development department of a multinational automobile manufacturer. The main selection criteria for this case study is the knowledge intensity of the PDD. The majority of employees in this department are well educated and highly qualified people engaged in intellectual work as part of their job requirements (Pina e Cunha, 2002; Alvesson, 2003; Lee, 2003; Swart and Kinnie, 2003). Intellectual work refers to the use of existing organisational knowledge to create new knowledge and value that the organisation as a whole can benefit from. Research on tacit knowledge in such a knowledge intensive environment holds high potential for eliciting insights on tacit knowledge use. The unit of analysis is knowledge workers in the development department of this organisation. Selection of the appropriate case study design is critical to the context of the sequential data collection method of this thesis in order to maximize the opportunity tacit knowledge insights and understanding. Yin (2014) and Gray (2009) describe four types of case study designs, distinguishing between two primary designs of a case study, a single-case design and a multiple-case design, and two further sublevels of those primary designs, a holistic level and an embedded level. The following paragraphs briefly explain the primary designs and sublevels leading up to the case study choice compatible with this research project.

3.6.1 The single case study design

According to Yin (2014) the single case design is an appropriate research design if the case is unusual, common, critical, revelatory or longitudinal. But he also emphasizes that in other situations a single case design can be used as a pilot case to support the start of a multiple case. In these circumstances, it would not be sufficient as a full study on its own. The single case holistic design is mainly to examine a single case on a holistic level. The focus is only on the global nature of an organisation or program on one analysis-level without any individual elements. It is also the appropriate design when the researcher is involved for the first time in an environment which has been difficult to access up to the point of entry where the researcher becomes an instant insider (e.g.: special groups, hidden structures, and secret organizations) (Feagin, Orum and Sjoberg, 1991; Gray, 2009; Yin, 2014). When the underlying theory of the

case is holistic, and the phenomenon is studied in context, the holistic design is worth choosing for testing hypotheses and theories (Brinberg and McGrath, 1985; Robson, 2002; Yin, 2014). If the single case contains analysis as more than one level, for example, analysis of different subunits, the resulting choice would be a single case embedded design. The identification of logical subunits will increase the complexity of research design, but it will also deliver enhanced case study insights (Gray, 2009; Yin, 2014).

3.6.2 The multiple case study design

A multiple case study design is given when the research contains more than one case, or rather when different entities as individual subjects of study are clustered within one study. This design is often used to cope with the claim of generalisability and reliability of a case study (Stake, 1995; Gray, 2009; Yin, 2014). Multiple case studies are seen as more robust and more compelling than single case studies, which is a clear advantage of the multiple design (Herriott and Firestone, 1983). The disadvantage of the multiple case design versus a single case design is the additional time and resource consumption. Yin (2014, p.57) highlights that specific characteristics of a single case study (critical, unusual, common and revelatory) cannot be handled within a multiple case study. The rules of a holistic or embedded design within a multiple case study are equal to the single case design. If there is no identification of subunits possible and the research focusses on only one level of analysis, then a holistic approach will be the appropriate design to conduct the research. When different subunits can be identified and the level of analysis, is beyond a single level then the embedded approach should be chosen for conducting the research. One challenge of a multiple case design, according to Yin (2014), is to consider multiple cases as one by using a literal replication or a theoretical replication logic. A literal replication logic predicts that major findings during execution of the research in one case will be similar to that found in further cases. Theoretical replications indicate contrasted findings in further cases versus the first case, but for anticipatable and explainable reasons.

3.6.3 The multiple case study approach versus the single case study approach

Yin (2014) states that the simplest setting of a multiple case approach would contain a minimum of two cases with exemplary outcomes by answering research questions based on how, what and why. This research project is conducted in the development section of a multinational car manufacturer and does not include different cases. Hence, the basic criteria of a multiple case study, within its simplest setting (two existing cases) as outlined above, is not given in the context of this project. Under such circumstances, the researcher’s decision of scientific case study framework points clearly to a single case study design.

3.6.4 Holistic versus embedded design

Conducting the research as a single case study with holistic design will limit the span of the research to only one organisation and this organisation will be investigated with the focus on the global nature in only one level of analysis.

The definition of tacit knowledge as embedded in personal experience, context related and strongly woven with personal perspectives, instincts and values, indicates that a clear demarcation of the phenomenon tacit knowledge to its natural context is not possible (Gourlay, 2004; Polanyi, 2009; Gascoigne, 2013). Rather, the natural context in which tacit knowledge appears is a necessary condition related to the phenomenon and appearances. Based on these tacit knowledge characteristics, it can be reasoned that multiple subunits of analysis are necessary to conduct constructive research on tacit knowledge. This research starts by identifying knowledge workers with a high use of tacit knowledge in the PDD. This step centres this research in subunit perspective. These subunits are individuals classified as knowledge workers in a department of an organisation. Individual elements of analysis in conducting a single case approach with a holistic design do not fit with the scope of the investigation and herewith not considered within the complexity of the phenomenon. By applying a single case study with a holistic design, this research would only focus on a narrowed section of this phenomenon. Therefore, a single case approach with a holistic design will not be sufficient to do research on tacit knowledge in this context.

The sufficient design of the single case approach must concentrate on different units and subunits of analysis. Selecting such subunits for analysis leads to an embedded design. This design allows a researcher to concentrate on different subunits of analysis which enhances insights on the case (Yin, 2014). Using this embedded single case study approach in this research, encouraged by the philosophy of a critical realist, enables the researcher to examine the phenomenon of tacit knowledge from different positions in different logical subunits of the department and delivers enhanced case study insights (Gray, 2009; Yin, 2014).

Summary: The embedded single case study design is the necessary approach in this thesis. An embedded design involves the analysis of important subunits of the context which delivering meaningful and powerful insights while protecting the results of the research against scientific validity and depth criticism. Hence the embedded design is better suited to this context and more productive in sequential research on tacit knowledge.

3.6.5 Summarizing the arguments for using a single case study design

The mixed method approach will be carried out within in an embedded single case study design, which, according to Eisenhardt and Graebner (2007), is a popular and often used research strategy in business research. This kind of empirical inquiry will allow this project's

researcher to focus on the phenomenon of tacit knowledge in its natural setting with real-world perspectives (Yin, 2014; Robson and McCartan, 2016).

Because this research focus is on the context of tacit knowledge, something not clearly and immediately apprehended -; the researcher is investigating possible relationships between the usage of job-related tacit knowledge from knowledge workers in different positions and its organisational as well as social contextualization. Morris and Wood (1991), Hartley (2004), Yin (2014) and Robson and McCartan (2016) emphasize that to achieve an essential understanding of a contemporary phenomenon and to identify relations and boundaries between the phenomenon to be explored and the context in which it appears, a case study strategy is the right choice. The loose structure of a case study strategy supports the sequential design in this research and makes it possible to fit the design and data collection methods to concrete answers to the highlighted research questions (Meyer, 2001).

Summarized here are the core arguments for case study design selection:

1. The loose structure with its supporting characteristic of handling multiple sources can accommodate a high number of internal variables;
2. the fact that tacit knowledge is not independent from social actors;
3. the focus of this research is on contextualization.

3.7 Methods used in research on tacit knowledge

3.7.1 Methods overview of different authors researching tacit knowledge

Research on tacit knowledge requires the identification of its variables, its sources and possessors. All techniques described in the literature contain elements which are used to identify and verify the existence of tacit knowledge in a specific context. Approaches highlighted in the current literature differ from each other primarily based on the context and the aim of the related study in which the approach was developed or tested. There is no dominant single method for formalising tacit knowledge found in the literature, which means various combination of methods are employed to formalise tacit knowledge. Therefore, the subsequent section summarizes different possible methods used uniquely or in combination by different authors to identify and manage tacit knowledge. Explicit techniques for the transfer or conversion of tacit knowledge, included in the aim of this thesis, are not part of this section. Table 3 presents methods used to identify and formalise tacit knowledge are:

Table 3: Methods used by different authors to elicit tacit knowledge

Methods	Authors
Techniques for observing, recording, and interpreting processes	(Scott, 1990; Liou, 1992; Hadikusumo and Rowlinson, 2004; Woo *et al.*, 2004; Garcia-Perez and Mitra, 2007; Teerajetgul and Chareonngam, 2008; Pourzolfaghar *et al.*, 2014).
Repertory grid as tool for capturing knowledge at an early stage	(Shema *et al.*, 1990; Liou, 1992; Bradshaw *et al.*, 1993; Herbig, Büssing and Ewert, 2001; Neve, 2003; Ryan and Connor, 2009; Goffin and Koners, 2011; Jafari, Akhavan and Nourizadeh, 2013; Pourzolfaghar *et al.*, 2014).
Concept mapping for generating a network to display nodes and links between different concept and ideas	(Ambrosini and Bowman, 2001; Haldin-Herrgard, 2003; Leake and Maguitman, 2003; Saad, Grundstein and Rosenthal-Sabroux, 2003; Fourie, Schilawa and Cloete, 2004; Srinivasan *et al.*, 2008; Do Rosário *et al.*, 2015).
Cognitive and mental maps for storing tacit knowledge with the purpose of further usage (e.g. problem solving, experience sharing)	(Tversky, 1993; Noh *et al.*, 2000; Tegarden and Sheetz, 2003; Abernethy *et al.*, 2005)
Delphi method for the conducting of systematically multi-level interviews, surveys and questionnaires	(Liou, 1992; Herbig, Büssing and Ewert, 2001; Nevo and Chan, 2007; Chu and Hwang, 2008)
Storytelling often used interview technique	(Sternberg and Horvath, 1999; Reamy, 2002; Kothari *et al.*, 2011; Venkitachalam and Busch, 2012; Whyte and Classen, 2012; Prasarnphanich, Janz and Patel, 2016)

3.7.2 Methods used in different studies to elicit tacit knowledge

The large number of different methods demonstrates the difficulties in identifying and formalising tacit knowledge in an organisation. The multiplicity research designs, methods and techniques in the literature is not only based on the aim and the environment of the research project, but also driven by the nature of tacit knowledge (personal knowledge, experienced based, practical knowledge and context dependent). Thus, it can be stated that the characteristics of tacit knowledge lead to complex approaches for elicitation. The table 4 below summarizes studies in research on tacit knowledge and their different characteristics sorted by publication date:

Table 4: The use of different methods to identify and elicit tacit knowledge

Author	Aim	Level	Domain	Data collection	Approach	Research design
Haldin-Herrgard (2003)	How epitomes of tacit knowledge can be used for mapping tacit knowledge in organisations.	Individual / Group	Asset management company in Finland.	Interview	Mixed Method	Case study
Saad, Grundstein and Rosenthal-Sabroux (2003)	Proposing a method to locate the company's crucial knowledge for improving the quality of a corporate memory in a design project.	Group	Automotive companies in France: (PSA / Peugeot / Citroen).	GAMETH Framework, backtracking	Qualitative	Case study
Jones (2005)	Eliciting factors for tacit knowledge sharing in enterprises which have introduced enterprise resource planning (ERP).	Group	Firms in the petroleum industry	Interviews	Qualitative	Case study
Garcia-Perez and Mitra (2007)	To explore how to provide an organisation with details about valuable tacit knowledge resources held by its members.	Individual / Group	Research	Observation, document analysis, interviews, questionnaires	Mixed Method	Action research
Borges (2012)	To examine how organisational, individual and environmental factors influence tacit knowledge sharing among IT professionals.	Group	IT-Workers	Questionnaires	Quantitative	Survey

Author	Aim	Level	Domain	Data collection	Approach	Research design
Jafari, Akhavan and Nourizadeh (2013)	To investigate employees of an organization in order to evaluate and classify them based on their tacit knowledge.	Individual	Automotive company in Iran.	Interviews, questionnaires	Mixed Method	Case study
Do Rosário *et al.* (2015)	Creation of model to transfer tacit knowledge to explicit knowledge and represent it in the form of production rules for use in manufacturing processes.	Group	Industry	Interviews, card sorting, observation	Quantitative	Action research
Al-Oqaily *et al.* (2015)	Development of efficient knowledge management methods to retrieve the right explicit knowledge from tacit knowledge based on responsible measurement variables and to aggregate and formulate the retrieved knowledge effectively for sharing valuable and focused knowledge.	Individual	Academic staff / University	Interviews	Qualitative	Case study
Sliwa and Patalas-Maliszewska (2015)	To create a model of converting tacit knowledge into explicit knowledge with Bayes algorithm for the R&D department in a manufacturing company.	Individual	R&D of a SME in the automotive industry	"Bayes algorithm"	Quantitative	Case study
Rashid, Bin Hassan and Al-Oqaily (2015)	To investigate the roles of knowledge and effectively knowledge measurement factors in the university environment.	Individual	Academic staff / University	Questionnaires	Quantitative	Survey

Author	Aim	Level	Domain	Data collection	Approach	Research design
Prasarnphanich, Janz and Patel (2016)	To elicit tacit knowledge from information system (IS) professionals to share with others and to develop categorical framework suggesting key content areas of tacit knowledge in the requirements analysis domain.	Individual	Information System	Requirement analysis, semi-structured interviews (storytelling approach)	Mixed Method	Case study
Rashid and Hassan (2016)	Development of a model to measure the academic staff members' levels of tacit knowledge based on practical variables.	Individual	Academic staff / University	Interviews	Qualitative	Case study
McIver and Wang (2016)	To develop a reliable and valid scale for measuring the underlying knowledge involved in work.	Individual	Health Care Org. Hospital	Interviews, questionnaires	Mixed Method	Survey
Muthuveloo, Shanmugam and Teoh (2017)	To explore and determine if organisations have strategies for tacit knowledge management which expect to influence their organisational tangibly and intangibly performance.	Group	Manufact. section of different industries located or listed in Malaysia	Questionnaires	Quantitative	Survey

No dominant approach for eliciting tacit knowledge appeared during this literature review. Methods used in research on tacit knowledge are strongly context specific. Therefore, a deeper investigation of approaches and methods used in research on tacit knowledge has been limited to studies with similar characteristics to the context of this research. This deeper investigation

has helped identify a sufficient approach and method to carry out tacit knowledge research in this context.

3.7.3 Mixed methods identified as an appropriate approach in this research

In the run-up to the selection the following two studies from the table above were identified, reviewed, and summarized as appropriate approaches for research on tacit knowledge in this context.

A study conducted by Jafari, Akhavan and Nourizadeh (2013) used a mixed method approach embedded in a case study setting. Techniques of data collection were interviews and questionnaires. The purpose of the study, which was done at an Iranian automaker and with this in a comparable business section to this study, was to categorize employees based on their tacit knowledge. Proceeding from the individual level of tacit knowledge, Jafari, Akhavan and Nourizadeh (2013) combined repertory grid technique and pathfinder analysis. Repertory grid supported the elicitation of personal relevant knowledge and the action guidance for verification of the findings. Pathfinder analysis was used for examination of data and creation of a personal knowledge structure for measuring tacit knowledge. The output was the classification of employees into four categories, to help the Human Resource Management department (HRM) to rank employee performance as a means of managing staff, especially knowledge workers, more efficiently.

Repertory grid technique was used in this study to elicit tacit knowledge. Jafari, Akhavan and Nourizadeh, (2013), Milton (2007) and Herbig *et al.* (2001) evidenced that the repertory grid technique is a valid method for eliciting tacit knowledge from individuals within an interview. Jafari, Akhavan and Nourizadeh (2013) started the process of identifying tacit knowledge by analysing the data collected from the participants during semi-structured interviews. Using an interview technique to collect data requires a specific situational setting. An interviewer and the interviewee. An interview is the collection of data from a living individual.

The strategy for this research for eliciting tacit knowledge in the PDD is based on the identification of tacit knowledge based on existing organisational data (job advertisements). Therefore, the approach from Jafari, Akhavan and Nourizadeh (2013), conducting interviews for eliciting tacit knowledge - does not fit the strategy of this study. In this study interview techniques are used for the second step of data collection and are applied as a technique for further exploring tacit knowledge in context, rather than for eliciting tacit knowledge. The fact that Jafari, Akhavan and Nourizadeh (2013) used a mixed method approach to elicit tacit knowledge and make it measurable confirms the idea of the researcher of this research. The researcher in this research does see an advantage in combining quantitative with qualitative methods with respect to rigor and quality of the possible findings of a study, which could well

lead to an increase in the confidence of the results (Webb, 1976; Denzin, 1989; Deacon, Bryman and Fenton, 1998; Gray, 2009). This strategy supports the critical realist stance of the researcher in this research, that acceptable knowledge can only be created through scientific approaches and settings (Bryman and Bell, 2015).

A further mixed method study on tacit knowledge at the individual and group levels was conducted by Garcia-Perez and Mitra (2007). Garcia-Perez and Mitra (2007, p. 373) claimed that most researchers agree on the importance of the identification and measurement of tacit knowledge though instruments, and that approaches are still missing in literature. According to Garcia-Perez and Mitra (2007), the literature on knowledge management mainly deals with the measurement of knowledge already made explicit, but for developing new strategies in knowledge management, research on tacit knowledge is essential. The study took place within a research organisation, which is seen as a similar environment to the one in this thesis. The study from Garcia-Perez and Mitra (2007) aimed to explore how an organisation could elicit and measure valued tacit knowledge held by the members in the organisation. The organisation was aware that knowledge resources in the organisation were not fully recognized. So the organisation requested for improvement of that situation, which, in turn, could solve problems caused by this lack of recognized knowledge (Garcia-Perez and Mitra, 2007, p. 376). Based on the characteristics of the organisation and the aim of the research, Garcia-Perez and Mitra (2007) adopted an interpretivist perspective embedded in an action research paradigm. Within a three-month timeframe, the project researchers collected data by observation, document analysis, interviews and questionnaires. Employee observation was done during task performance. The e-mail exchange between managers and their subordinates and the e-mail communication between the members of the action research teams were analysed. Meeting notes from different meetings were taken into consideration. This part of data collection aimed to build researchers knowledge of the organisation. The fact that the researcher in this thesis is a member of the organisation in which research is performed and the researcher is familiar with the organisation, this step can be ignored in considering method adoption. Garcia-Perez and Mitra, 2007 (p. 378) decided to use interview-based techniques including questionnaires for tacit knowledge elicitation which explains the second part of data collection. Garcia-Perez and Mitra (2007) described, the use of interviews and questionnaires and the analysis of the collected data as a two-phase methodological framework to identify and measure tacit knowledge in an organisation (Garcia-Perez and Mitra, 2007, p. 383). The identification of tacit knowledge resources was based on the interpretation of interviews. An interpretivist stance, as was adopted in this related study for the identification of tacit knowledge resources includes a risk of fuzziness in the results. Garcia-Perez and Mitra (2007) faced that risk by conducting interviews at all hierarchy levels of the enterprise and aligning the interview outputs to generate a deep and consistent understanding of the interview

and questionnaire data. A general question arises in using this strategy for the identification of tacit knowledge: the question of the rigor in results by replication of this approach. It is a question not answered by Garcia-Perez and Mitra (2007) and a concern not reduced by the relatively low number of participants (n=16) who took part in this research. As mentioned above, the researcher of this project does see a more reliable approach for identifying tacit knowledge in an organisation by the use of data which already exists as explicit static organisational data which would increase the quality of the results in a study replication work stream. Furthermore, the analysis of existing data less costly and time consuming than approach which starts with the collection and creation of data to identify tacit knowledge in an organisation. Time and cost variables are essential elements in an enterprise choosing a method. The second phase of the approach from Garcia-Perez and Mitra (2007) was the verification and the measuring of tacit knowledge. The management board was asked to rate the perceived importance of tacit competencies identified during the previously conducted the interviews. Hence, measurement was achieved through a numerical value. Results were analysed and validated by a second interview phase within the management board.

Garcia-Perez and Mitra (2007, p. 383) highlighted an issue related to the application of this method to other organisations. The results of the analysis of the collected data and the conducted rating exercise depends strongly on the characteristics of the organisation and the scope of study. Such a statement clearly disallows the generalisability of the results and the general application of this method in another context.

Both reviewed studies start with research identifying and locating tacit knowledge in an organisation before further investigations on tacit knowledge take place. In summary, it turned out that the identification of tacit knowledge resources in an organisation is recognized as an essential first step on which further research is built. Hence, a two-step research process; which consists of identifying tacit knowledge in the first step and further exploration of tacit knowledge in the second step, is considered constructive. Tacit knowledge, because of its hidden characteristics is a topic made for sequential research. A sequential approach helps uncover tacit knowledge layer by layer. Applying a sequential approach using mixed methods, as it was done from Jafari, Akhavan and Nourizadeh (2013) and Garcia-Perez and Mitra (2007), has crucial advantages enabling the researcher of this thesis to explore the use of tacit knowledge in this organisation from different angles. This explorative opportunity is inherent in the use of mixed methods and is not available using a single method approach. Hence, the use of mixed methods is recognized as an appropriate strategy to identify and further explore the use of tacit knowledge.

3.8 The use of mixed methods in this thesis for research on tacit knowledge

A literature review carried out by Massaro, Dumay and Garlatti (2015) on research methods in the public sector of knowledge management shows that only seven percent of such studies were conducted using a mixed method approach. This seems to be a very small share of mixed method research application when compared to the literature highlighting advantages of combining quantitative with qualitative methods with respect to the robustness and the increase in confidence of the research outcomes in the field of research on knowledge management (Webb, 1976; Denzin, 1989; Deacon, Bryman and Fenton, 1998; Gray, 2009). “Mixed methods as research method focus on collecting, analysing and mixing both qualitative and quantitative data in a single case study or series of study” (Creswell and Plano Clark, 2007, p. 5). The above reviewed studies from Jafari, Akhavan and Nourizadeh (2013) and Garcia-Perez and Mitra (2007) are drawing exactly this picture. Both studies used mixed methods to realise different points of view on the tacit knowledge phenomenon and increase the depth of exploration.

This research includes four different questions exploring the use of tacit knowledge in this organisation. Answering research questions (RQ1) and (RQ2) employs a quantitative method in research step one; answering research questions (RQ3) and (RQ4), a qualitative method in research step two. Gray (2009, p. 36) notes that while one method is appropriate for one research question, it might be inappropriate for another. Hence, the use of mixed methods helps handle the need for the use of different methods in a research project to answer different research questions. The sequential approach in this research, the identified need for more than one method to answer the questions in this research, and the above highlighted advantages of using mixed methods displayed in the existing literature lead to the decision to conduct this research based on a mixed method approach. Beyond the appropriateness of mixed methods for the characteristics of this research, the use of mixed methods in this research generates also further knowledge regarding the application potential of mixed methods in research on tacit knowledge.

3.9 The two research steps in this sequential research

Research Step 1 – Quantitative approach

Research step one in this two-step sequential research follows a quantitative approach. Content analysis as a systematic and replicable research method to study documents based on explicit rules of coding to analyse patterns in the data is used to investigate the usage of ETK in internal job advertisements in the PDD (Krippendorff, 2013). Eighty-four job advertisements of different knowledge worker positions from the last three years were

analysed. Analysing the frequency of appearance of these ETK creates a picture of tacit knowledge usage by PDD knowledge workers. In the first step of research, the differences in the amount of tacit knowledge usage among knowledge workers in different salary groups is classified. Knowledge workers with the highest use of tacit knowledge are identified. Furthermore, specific tacit knowledge frequently used by knowledge workers in this department is elicited. Summarized, the purpose of research step one to identify the critical variables of tacit knowledge usage in the PDD by understanding how the usage of tacit knowledge differs among knowledge workers in different positions and what specific tacit knowledge is frequently used.

The analysis of the data in research step one helps answer the research questions one (RQ1) and two (RQ2):

RQ1: How does the usage of job-related tacit knowledge differ between knowledge workers in different positions within the product development department of a multinational automotive manufacturer in Germany?

The number of counted ETK used in internal job advertisements related to knowledge worker positions in different salary groups draws a picture on the amount of tacit knowledge required from a knowledge worker to perform relative to the position. The difference in the number of used ETK in each position and relative to a specific salary group helps identify the knowledge workers who possess a great deal of tacit knowledge in their positions. Identifying these knowledge workers is analogous to identifying the most critical knowledge loss risks in an unusually large retirement pool. Critical is used because losing these workers and their tacit knowledge will impact seriously the organisational performance.

RQ2: What specific tacit knowledge is frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

The analysis of the type and the distribution of those ETK used in the different job advertisements for different positions relative to different salary groups leads to the identification of specific tacit knowledge in the form of ETK frequently used in the PDD.

Research Step 2 – Quantitative approach

Research step two in this sequential research builds on the results from research step one and follows a qualitative approach. Twenty-two semi structured interviews with knowledge workers in the PDD were conducted. Since tacit knowledge is context related and embedded in individuals, administration of interviews with PPD knowledge workers as possessors and users of tacit knowledge is required to further explore their ways of application. Though the frequently

used ETK identified in research step one are concrete terms, their meaning among individuals in different contexts may vary. Therefore, the administration of semi structured interviews in research step two is necessary to verify the findings in research step one and to elicit the deeper context related meaning behind the various ETK applied in the PDD. Hence, research step two concentrates on specific tacit knowledge frequently used in the PDD by knowledge workers with the highest amount of tacit knowledge usage as identified in research step one. Concentrating on knowledge workers with the highest amount of tacit knowledge usage and their specific tacit knowledge forms frequently in use allows narrowing of the investigation to the critical variables of tacit knowledge usage in the PDD. Critical is meant here, as before, the impact on organisational success as these employees retire in large number and take their tacit knowledge with them. Thematic analysis as a method of analysis frequently used in qualitative research to systematically identify and organize patterns of meanings in data is applied to the data gathered through semi-structured interviews to achieve deeper insights regarding how specific tacit knowledge is frequently used in the PDD (Braun and Clarke, 2006, 2012; Guest, MacQueen and Namey, 2011). The results from the analysis of the data gathered in research step two are used to answer research questions three (RQ3) and four (RQ4):

RQ3: How is specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

RQ4: What is the purpose for the application of specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

For the sake of clarity, the author will provide detailed argumentation on the appropriateness of the approach and method used for each single research step in their respective chapters. These detailed explanations of methods used for data analysis in each research step will support the reader in creating a better understanding of the interdependencies between the method and the context in which the method was applied.

Chapter 4: Research step one: Eliciting tacit knowledge usage in the PDD

This chapter describes how research step one was conducted to classify knowledge workers according to the amount of required tacit knowledge needed to perform in their position and how frequently used tacit knowledge by knowledge workers in the PDD was identified. It delivers an explanation of the method used to analyse the job advertisements and how this method formed the approach used in this research step. The sample characteristics of research step one are outlined and the data analysis from research step one is summarized. Finally, research questions (RQ1) and (RQ2) are answered.

4.1 Quantitative content analysis for decoding job advertisements

Knowing that the identification of tacit knowledge use in an organisation is one of the most challenging factors in tacit knowledge research, research step one focuses on to detecting and to mapping the amount of tacit knowledge related to different specific units in the organisation by using the concept of ETK developed by Haldin-Herrgard (2003). This first step is the study of internal job advertisements of the car manufacturer. This is a quantitative approach using content analysis.

Content analysis is a systematic and replicable research method to study documents, texts, pictures and videos based on explicit rules of coding and to analyse patterns in the data, thus enabling a researcher to answer research questions (Krippendorff, 2013). Silverman (2014) and Neuman (2014) argue that content analysis is a quantitative method while Lune and Berg (2016) and Insch, Moore and Murphy (1997) contend that content analysis can be both, quantitative and qualitative. It can be stated that content analysis is used in qualitative and quantitative research and is defined as empirical scientific method used for the systematic and replicable analysis of all written texts to uncover manifest and latent content of a text (Newbold, Boyd-Barrett and Bulk, 2002).

In the beginning of the 19th century content analysis was used as quantitative method to analyse newspapers. Later, in World War II it was also used as a quantitative method to analyse propaganda. Thereafter, it diffused into other disciplines and was used as qualitative method as well (Krippendorff, 2013; Lock and Seele, 2015). Using content analysis in business research is, according to Insch, Moore and Murphy (1997), not very common. The reason for this is seen in a lack of researcher familiarity with the method, but it is now frequently used in the analysis of business communication (Podsakoff and Dalton, 1987; Weber, 1990; Bryman, 1992). Walsh (1975) and Todd, McKeen and Gallupe (1995) have proved in their studies that content analysis is a valid approach for analysing job advertisements, a result underpinned by

Harris (2001) finding that content analysis is an appropriate method for examining secondary data.

Furthermore, content analysis builds a robust foundation for the use of multiple methods, a characteristic of content analysis that best fits into the design of this research (Harris, 2001). In the study from Todd, McKeen and Gallupe (1995), content analysis was used for decoding job advertisements to examine the evolution of required skills for positions in the sector of information system professionals. Their study applied coding rules to determine how a researcher identifies, interprets and converts the unit of text for content analysis. These coding rules include a classification of phrases into categories to ensure that all used phrases reflected in the content of the different job advertisements, placed in four different newspapers, in the period over twenty years, are made processable.

The approach from Haldin-Herrgard (2003) delivers with the epitomes of tacit knowledge the core logic for coding in this research. A classification process as it was used from Todd, McKeen and Gallupe (1995) to convert phrases into countable units is therefore not necessary. ETK are clearly defined terms and building with this single coding units which can be detected and counted. Analysing a text with respect to the appearance of a word is defined as manifest content analysis and is the focus of the process of analysis only on the counting of the frequency of specific words, the analysis would be quantitative (Potter and Levine-Donnerstein, 1999; Kondracki, Wellman and Amundson, 2002). A definition of quantitative manifest content analysis which perfectly describes the characteristics from research step one in this research.

At this point it need to be emphasized that the enabler for stopping the data analysis after the counting of the epitomes and still being able to create results out of the counting with respect to the use of tacit knowledge in the organisation was the adaptation of the framework from the method developed by Haldin-Herrgard (2000, 2003). The author of this thesis analysed internal job advertisements with respect to the appearance of epitomes of tacit knowledge. As proved by Haldin-Herrgard (2000, 2003) that these epitomes are subtypes of tacit knowledge and are related to the use of tacit knowledge, the researcher in this research identified and mapped the usage of tacit knowledge by counting the epitomes in internal job advertisements. Emerging patterns and relationships between different variables are identified during the manifest content analysis of the secondary data. Using secondary data (internal job advertisements) during content analysis is unobtrusive and met this research objectivity criteria. Hence it helped the researcher to avoid subjectivism (Krippendorff, 2013).

Summarized, the purposes of this inductive first research step are:

A. To identify the use of tacit knowledge by knowledge workers in the PDD.
B. To understand how the amount of tacit knowledge usage distinguishes in different positions of knowledge workers in the PDD.
C. To identify knowledge worker with the highest amount of tacit knowledge usage.
D. To identify specific tacit knowledge that is frequently used by knowledge workers in the PDD.

4.1.1 Translating epitomes of tacit knowledge from English to German

The internal job advertisements reviewed in this work are written in German language. To use the concept of ETK from Haldin-Herrgard (2003), the list of epitomes of tacit knowledge were translated from English to German. The step of translating the epitomes from English into German is essential to make the approach from Haldin-Herrgard (2003) work in the context of this research.

The literature on cross-cultural translation highlights different challenges a researcher must face to during the translation of textual content from one language into another language. The guarantee of translation equivalence is the most often highlighted challenge in language translation exercises (Brislin, 1970; Baker, 2006). Given the risk of a change in meaning of a text during the process of translation, equivalence or translation equivalence became a quality criterion for translating exercises (Genkova, 2015). To ensure the best possible translation quality, the researcher in this research used back-translation as technique for validation (Brislin, 1970; Baker, 2006).

There are multiple versions of process steps in performing back translations. Basically, the process of back-translation can be broken down into four main sections: initial translation, back or re-translation, review and alignment of results, finalization. Back-translation needs to be performed by at least two different translators. The leanest setting for this exercise describes two translators. Translator A who translates the original source to the target language and translator B who re-translates the translation back into the source language without knowing the initial source language terms (Brislin, 1970; Baker, 2006). The back-translation and the original translation are compared to each other. If no inconsistencies are found, the translation is judge as equivalent (Brislin, 1970). Haldin-Herrgard (2003, p. 102) called the step of translating the epitomes “preparation of tools” and refers to the step as an adjustment of the epitomes to the local language.

To apply the logic of back-translation the researcher used the service of two professional translators. These translators are English native speakers, born and grown up in the United Kingdom and living and working in Germany. Both translators are familiar with the German

language and are teaching at business schools in Germany. The reason for mentioning these personal characteristics of the translators is necessary to guarantee the quality of the translation. Translating epitomes of tacit knowledge is an exercise requiring familiarity with both languages involved in the translation and as well the cultures behind both languages. Simple translation by using commercial translation programs (e.g. Google Translate) from English epitomes to German epitomes without considering the cultural factor behind such epitomes can lead previously mentioned loss in the meaning of the epitomes, thus rendering low equivalence resulting from poor quality of translation. The professional and private background characteristics of the above mentioned translators, shows that both are bilingual and familiar with the cultures behind both languages, a best practice setting for translation (Lou *et al.*, 2016). Furthermore, are both translators familiar with this project, which delivers an additional enhancement on the holistic quality of the translation process.

The back-translation process was performed by two translators and moderated by the researcher of this thesis. The researcher distributed the original English list of ninety-two epitomes to Translator A, requesting translation to German. After receiving Translator A's work, the researcher prepared a separate file containing only Translator A's German-language content and forwarded it to Translator B, requesting translation to English, hence re-translation or back-translation of the ninety-two epitomes. The aim of this exercise was to guarantee that Translator B is blinded to the source language terms. After completion of the back-translation from Translator B, the researcher compared and analysed both translation results with each other. The level of equivalence was one hundred percent.

An alignment on the translation output between both translators moderated by the researcher was carried out in a separate meeting. During this meeting both translators were briefed of the back-translation process they had unconsciously are already participated in. Not informing the translators of the back- translation process helped to avoid any informational exchange between the two translators, thus avoiding biased positions. An open verbal exchange between both translators took place in that meeting. Purpose of this meeting was to inform both translators of the results and to realign on a final standardized version of translation. Nida (1964) and Brislin (1970) agree that the most important requirement of a translation is the equivalence of meaning. Brislin (1970, p. 185) stated that the quality of translation is predictable and that functional equivalence in a translation can be demonstrated by the process of back translation.

Applying this logic to the output of the back-translation process, it can be stated that no inconsistencies between the original document and the back-translation were detected; the translation is rated as equivalent. It must be highlighted that the literature on translation mainly describes the translation of questionnaires, texts and complete results of studies. Translation

of such textual content requires the consideration of syntax and grammar to avoid changing of the meaning of a text during the translation (Halverson, 2004; Baker, 2006; Lou *et al.*, 2016). Thus, the processes of translation behind the most-often described approaches are partially interpretive and quite complex.

The ninety-two epitomes are single terms and not embedded in a sentence. Hence the complexity of translating the meaning of a complete sentence by analysing grammar and syntax is not necessary. This means as well that the translation of single terms is only based on vocabulary knowledge and not related to the interpretation of meaning by analysing syntax and grammar. But the circumstance that the given terms (epitomes of tacit knowledge) are not embedded in a sentence leads to translation results which end up with more than one word of translation for one single term so as to cover as many context or syntax cases for each term (epitome of tacit knowledge) as possible. This circumstance is anchored in the method from Haldin-Herrgard (2003). Haldin-Herrgard (2004, p. 6) highlighted that there is no single contextual usage of the identified epitomes. Epitomes are applied by different scholars in different ways to convey meaning in context; similarly, they may choose to apply different epitomes even when discussing the same or similar topics with each other – in writing or in speaking. This circumstance underpins the multiple ways of applying epitomes of tacit knowledge under different research contexts and supports the validity of the translation approach in this thesis with respect to more than one-word translation. An overview of the translated epitomes is found in Appendix 3. The next section outlines the coding scheme used in this thesis.

4.1.2 Coding rules used in this thesis

According to Weber (1990) there is no common simple way for conducting content analysis. To ensure that the method of manifest content analysis used in this thesis is accepted as a valid research design, the research method demands reproducibility reliability and stability reliability. The development of coding rules that determine how each unit in the data is proceeded ensures this demand (Weber, 1990; Todd, McKeen and Gallupe, 1995; Insch, Moore and Murphy, 1997; Newbold, Boyd-Barrett and Bulk, 2002). After the translation of the epitomes of tacit knowledge from English into German (see above), the compatibility between the language used in the internal job advertisements and the epitomes was given. These epitomes build the coding units in this work. Every internal job advertisement has the same structure. It consists from top to bottom of mainly eight sections:

- Nomenclature of the job
- Table of specific organisational and administrative information
- Area of responsibilities
- Education and professional experience

- Special skills and knowledge
- Language ability
- Further information
- Contacts for submitting the application

An example of a job advertisement is attached in the appendix of this thesis (see Appendix 5). The sections “Ausbildung und Berufserfahrung” (education and professional experience) and “Besondere Fähigkeiten und Kenntnisse” (special skills / abilities and knowledge) refer to the body of knowledge, experience and skills an employee must possess to be able to perform successful in the highlighted position. Due to the fact that tacit knowledge is deeply interwoven in these criteria, the researcher of this thesis limits the coding of the job advertisements to these two sections. A further benefit in answering the research questions in this work by coding the other sections of the internal job advertisement is not seen. The manifest content analysis in research step one is a quantitative approach, which means epitomes of tacit knowledge used in job advertisements are counted and the analysis of the job advertisement is limited to the counting of the frequency of ETK without any additional interpretation of the content (Potter and Levine-Donnerstein, 1999; Kondracki, Wellman and Amundson, 2002).

To ensure reproducibility reliability and stability reliability of the manifest content analysis, clear recording instructions / coding rules were developed. The researcher in this research defined coding rules, based on the identified epitomes from the approach from Haldin-Herrgard (2003). A circumstance that guarantees reproducibility, stability and reliability of the approach. As recommended by Insch, Moore and Murphy (1997) a pilot test was done by the researcher of this thesis. The pilot test helped to develop the coding rules in this thesis. In the pilot test two job advertisements of each salary group in each year were analysed. During the pilot testing the researcher determined that a rough classification of the epitomes from Haldin-Herrgard (2003) would be helpful to increase the efficiency in coding. Haldin-Herrgard (2003) defined the epitomes personal experience and collective experience. Haldin-Herrgard (2003) describes with personal and collective the specific type of experience, a level of detail that is not necessary in step 1 of data gathering to elicit the use tacit knowledge hidden in an internal job advertisement. Therefore, the researcher of this work only screened the job advertisements for the epitome experience (“Erfahrung”) without any further breakdown of the epitome experience. Experience (“Erfahrung”) forms one class of ETK.

Furthermore, the epitomes in German are often part of a word and do not stand alone. For example: The epitomes ability, skill, capability, competence, experience (just to name a few) are often in the connection with another word, a word that describes a case, or specific field in which the epitome is used. An example is the usage of the German word “Fähigkeit” (ability). In German the word, “Teamfähigkeit” means the ability to work in a team. The epitome in this

case is “Fähigkeit” (ability) which is connected to the word “Team”. As far as an ETK is linked to another attribute like “Fähigkeit” (ability) to “Team”, the complete word will be tracked in the data gathering. As part of the analysis of the gathered data such connected words are allocated to a specific ETK. The purpose is to summarize those connected words in specific classes of related ETK. To stick to the example: “Teamfähigkeit”, this connected word will be located in the ETK class “ability”. This process ensures the right allocation of connected words to the related ETK header.

Summarized, the following coding instructions build the coding scheme of this work:

1. The sections of analysis in the job advertisements are limited to the sections: “Ausbildung und Berufserfahrung” (education and professional experience) and “Besondere Fähigkeiten und Kenntnisse” (special skills / abilities and knowledge).

2. The use of a hyphen requires the counting of the word with the hyphen if the hyphen is related to an epitome. (E.g.: Team- und Kommunikationsfähigkeit will be translated into Teamfähigkeit und Kommunikationsfähigkeit. The hyphen is replaced by the epitome to which the hyphen was related to).

3. The coding units are the German translation of the epitomes introduced from Haldin-Herrgard (2003). (Find the table of translated epitomes in the appendix of this thesis. Appendix 3)

4. Words built from ETK and other words are coded in full.

Each job advertisement is reviewed as digital PDF document stored on an internal enterprise server. For each salary group, the id number, the title, and the sections of analysis of the internal job advertisement are recorded in writing, in tables separated by calendar years. ETK within the section of analysis in each internal job advertisements were identified, counted and recorded by the researcher of this work. The recorded epitomes were linked to the related internal job advertisement.

4.2 Internal job advertisements as an indicator for the use of tacit knowledge

The importance of tacit knowledge retention for an organisation to stay operative and competitive was extensively described above. Liebowitz (2009), Levy (2011), Durst, Aggestam and Ferenhof (2015) claim that in the academic sector as well in organisations, there is a lack of process development to prevent knowledge loss, even if both parties know about the risks of knowledge loss. Hence there is still a need to create approaches which can be used by organisations for the purpose of knowledge retention. Making tacit knowledge recognizable by the use of a tool can be a fundamental basis to create process against the loss of tacit

knowledge. Results from such an exercise would be implemented in organisational strategies in the form of knowledge transfer - or knowledge - protection actions. The business sector calls for solutions which are practical, useful, easy to apply, reliable, and not time or cost intensive. Such criteria make research on tacit knowledge even more challenging. To perform within this limited frame of resources and to fulfil the given requirements, it is necessary to adopt existing methods for eliciting tacit knowledge instead of reinventing the wheel, by building up new methods.

To use existing approaches for the management of tacit knowledge in business, it is necessary to move and transform existing approaches for research on tacit knowledge from the theoretical or academic sector to practice. The researcher has outlined the importance of tacit knowledge for organisations, which is already well recognized in the academic sector. To draw the conclusion that the role of tacit knowledge is so important for an organisation requires the use of tacit knowledge and the ability to reflect on the effects caused by the usage of tacit knowledge, a circumstance the researcher builds on, by presuming that the existence of tacit knowledge leaves marks in an organisation, marks traceable by using the right method. As Polanyi (1966) described the use of identity cards as method to elicit tacit knowledge from persons with respect to the characteristics of a face, the researcher of this thesis recognized similar potential for eliciting tacit knowledge in organisations in the methodology of Haldin-Herrgard, (2003). Haldin-Herrgard`s (2003) approach of eliciting and mapping tacit knowledge was published and accepted by the scholarly community. Additionally, McAdam, Mason and McCrory (2007b) have explicitly requested further research on the potential of using of epitomes of tacit knowledge for managing tacit knowledge.

Using the conceptual framework from Haldin-Herrgard (2003) to elicit and map tacit knowledge in an organisation takes the approach from Haldin-Herrgard (2003) to the next level. Epitomes as subtypes of tacit knowledge enable the researcher of this thesis to screen internal job advertisements for the use of these epitomes, to identify the potential use of tacit knowledge in a specific position in an organisation. Epitomes of tacit knowledge represent in this context a possibility to decode tacit knowledge from existing organisational data and make it available to the researcher. Using internal job advertisements as source of data sensitises the researcher of this project to possible relations between the use of tacit knowledge and organisational data and is explained by the hidden explanatory power and quality of such internal job advertisements.

A study by Todd, McKeen and Gallupe (1995) highlights a potential objectivity limitation in using job advertisements in research, namely that of advertisement creator bias. Having drawn attention to this potential, the process of creating such advertisements must be examined for evidence of such conflicts. The job advertisements in this organisation are the result of process

designed minimize the risk of a bias-laden posting. The creation of an internal job advertisement is done by a senior supervisor ranked above the position which need to be described. The senior builds the description based on personal experience collected while he or she held the specific or similar position or based on observations of the requirements of the position that he or she has made as a leader in the department. After the completion of such an internal job advertisement and prior to the enterprise internal publication, the job advertisement is reviewed by the Human Resources Department and the Department of the Working Council. Using the Six-Eyes principle ensures a more object advertisement and a maximum of quality of an internal job advertisement and consolidates specialist experience on job requirements of three parties. This means the data from the job advertisements not only deliver similar data to the data Haldin-Herrgard (2003) has used, it delivers data of sufficient quality by the use of three gatekeepers in the process of creating an internal job advertisement.

A further argument for identifying internal job advertisements as valuable source of data for the research on tacit knowledge is based on a theory developed by Fine (1996). Fine (1996) explains in his writing that biologists study fruit fly species because the extreme short lifecycles of fruit flies makes it possible for researcher to observe the genetic development of hundreds of generations within such a short time frame. Researchers are able to identify the genetic adjustments a fruit fly made to survive in a constantly changing environment within short periods. Based on this he created the theory of looking for the fruit flies in the business sector. Identifying the fruit-fly enterprises, also named as clock speed maker, will help the observing enterprises to learn from the fast development of the “fruit fly” enterprises. This can help observing enterprises to avoid mistakes made by others, and to increase a) the efficiency of performance, b) the speed of necessary transformation, and c) adjustments to stay competitive in a future market. The researcher of this research was inspired by this theory and applied this logic of identifying the fruit flies to the available organisational data.

Internal job advertisements seem to be to fruit flies of organisational data. An internal job advertisement reacts quickly to changes in business or market requirements and often involves lessons learnt from seniors. An internal job advertisement at most displays the latest identified standard of required skills, experiences, and knowledge an employee must possess to perform successfully in the vacant position of today. Hence analysing data from internal job advertisements deliver up-to-date information, invaluable for up-to-date awareness.

The hidden potential of using job advertisements as a source of data for analysis was already proved in a study from Walsh (1975). Over a period of four years, Walsh (1975) analysed the help wanted advertisements in daily newspapers. The study presented that job advertisements are of significant value to specific employers to recruit employees. For large organisations, job advertisements are an essential tool to successfully recruit professionals, managerial and

technical workers (Walsh, 1975, p. 89). The results have shown that it is possible to systematically analyse the data in job advertisements to assess their content and their importance for employers and job applicants (Walsh, 1975, p. 89). Todd, McKeen and Gallupe (1995) have also used an approach to analyse job advertisements. The approach used by Todd, McKeen and Gallupe (1995) has similar characteristics to the approach used in this thesis. Job advertisements from four different regional newspapers were analysed over a period over 20 years (1970-1990) to examine the evolution of job skills requirements in positions for information system professionals. Walsh (1975) and Todd, McKeen and Gallupe (1995) have demonstrated that job advertisements contain valuable organisational data which build valid sources of data for research. Furthermore, they have shown that content analysis is a valid approach for analysing job advertisements. These results can be underpinned by the finding from Harris (2001), that content analysis is an appropriate method for examining secondary data.

Beside these supporting arguments for the research approach carried out in this research, the study from Todd, McKeen and Gallupe (1995) highlights further limitations of the method they used. Further limitations of the study highlighted by Todd, McKeen and Gallupe (1995) were seen in the question if the only purpose of placing a job advertisement by an organisation in a newspaper is to hire employees with the right skills or is there also the intention of an organisation to promote the image of itself by overrepresenting the ideal picture of a possible candidate in the job advertisement. Todd, McKeen and Gallupe, (1995, p. 19) haven´t seen a conflict potential between the specification of skill requirements in a job advertisement and the existence of different intentions of an organisation to place a job advertisement in a newspaper. It seemed reasonable to them that there is no real benefit for an organisation to consciously misrepresent the required skills for a position within a job ad, because the final decision if a candidate suits a position is always made in a personal interview. Overrepresenting skills in a job ad will only make the possible candidate more sensitive for the expectation of the organisation.

This limitation to the approach of using job advertisements as samples is not seen in this research. Due to the facts that a) the researcher of this thesis is using internal job advertisements which are used for internal purposes only and b) as already mentioned, that the creation of these internal job advertisements is monitored from three different stakeholders, ensures that there is no biased content within these job advertisement based on the possible intentions of an organisation for placing a job ad in a newspaper as outlined from Todd, McKeen and Gallupe (1995). Data gathering step one in this research builds on existing data. Summarized it can be stated that the existing data, the internal job advertisements, were not created for the purpose of research hence the data wasn´t generated to meet the needs of the

researcher. Using this data allows an unbiased research in this context. Compared to the work from Walsh (1975) and Todd, McKeen and Gallupe (1995) the approach of this thesis to use existing data, allows the researcher to conduct a cross-sectional study which does require less time and less resources.

4.3 Sample strategy and data criteria

The researcher of this project got access to the data base of the Human Resource department of the car manufacturer. The data of internal job advertisements from calendar years 2015, 2016 and 2017 across all enterprise sections and all salary groups are stored in that data base, a total of 641 internal job advertisements. Research on tacit knowledge is most promising in the field of knowledge work which appears, according to scholars of tacit knowledge (see above) in the product development section of an enterprise, hence the focus of data gathering is limited to the product development department of this enterprise. The number of internal job advertisements related to the product development section overall salary groups is 362, which is of the overall job advertisements 56%.

As mentioned above due to the importance of a knowledge worker to an organisation, this research concentrates on the positions of knowledge workers. Based on the statement from Davenport (2005), Hammer, Leonard and Davenport (2004) and Sulek and Marucheck (1994) that knowledge workers including academics and engineers, and that all knowledge workers are ranked highly in an organisation, the scope for data analysis was limited to four specific salary groups fulfilling these characteristics.

A salary group represents an income level and is related to a specific educational background. Each position in the PDD is classified into a salary group. This classification is based on the needed educational background and characteristics an employee has to own to perform in this position. For an employee to perform in these salary groups he or she has to prove that they possess the described type of educational background (academical degree) to become possible candidate access to these positions. The total range of salary groups in this enterprise is from EG6 up to LL1. Positions classified in the salary groups from EG6 up to EG12 require no academical degree to perform in such a position. EG13 and higher require an academic degree to perform in these positions. The four salary groups investigated in this research are EG13, EG14, AT and LL6. The salary groups are not related to a specific field like for example engineering or finance or a specific type of job like for example an electrical engineer or a financial controller, they are rather related to the level of responsibility, autonomy and specialisation in a position. Every salary group occurs in each field of the PDD. The order EG13, EG14, AT and LL6 represents an increase in responsibility, autonomy, specialisation and income from EG13 to LL6. Furthermore, is LL6 the first leadership level, means with this level an employee has subordinated employees.

The high amount of these specific salary groups (EG13, EG14, AT, LL6), which are identified as knowledge worker positions versus the salary groups of the non-knowledge worker positions within the product development section of the enterprise underpins the statement from Sliwa and Patalas-Maliszewska (2015) that knowledge workers are mostly employed in the field of product development of an organisation.

Focusing on these salary groups reduces the number of internal job advertisements from 362 to 318 or 88% of all advertisements related to the product development group and 50% of all internal job advertisement across all sections and salary groups. The process of sampling depends, according to Marshall (1996), on the aim of the research. The first step of data gathering is quantitative and utilises quantitative content analysis, meaning a counting exercise as the research objective to sensitise the researcher to the data and possible existing relations between different organisational characteristics. To avoid subjective judgement of samples, the researcher uses random sampling. Marshall (1996) states that random sampling is the most commonly used approach because in a random sampling process, the chance of selection for every sample is equal. Random sampling is identified as an enabler to achieve the desired objectivity in data gathering step one (Marshall, 1996).

Each job advertisement is coded with a numerical ID. This numerical ID was generated by the HR department of the enterprise and is normally used to identify, sort, and store the data. All numerical IDs are listed in a table separated by years and salary groups. Random sampling is, according to Yamane (1967), an excellent tool to work on such exhaustive lists. The researcher of this project used the random number function from MS Excel to identify the samples for examination, meaning that the researcher listed all numerical IDs of the different job advertisements separated by years and salary groups in MS Excel and linked each ID with a random number generated by MS Excel. The numerical IDs related to the internal job advertisements and linked to the random number created by MS Excel were sorted according to this random number from small to large. Before identifying the final samples, the arguments behind the total sample size must be outlined.

Todd, McKeen and Gallupe (1995) in their study to examine the evolution of required skills for positions in the sector of information system professionals used a total sample size of 1234 job advertisements. The study itself was a longitudinal study carried out by three researchers within the time frame over twenty years. Three job types were investigated. This averages out to a sample size of twenty-one job advertisements per year of research and per job type. Developing the sample size of this study by applying the variables from the study above and considering that the study carried out in this thesis is a cross-sectional study which does not have the resources to employ three researchers, the total sample size of this study is calculated with eighty-four job advertisements, four salary groups to be investigated multiplied

with twenty-one job advertisements. The sample size from the cross-sectional Haldin-Herrgard (2003) study was twenty-two employees. Marshall (1996, p. 522) emphasized that a sampling error is inversely proportional to the square of root of the sample size, there is such minor benefit in studying very large samples. Combining the above-outlined sample sizes of the study from Todd, McKeen and Gallupe (1995), Haldin-Herrgard (2003) and the statement from Marshall (1996), and maximizing the robustness in the results as well minimizing the margin of error, a sample size for research step one in this thesis of eighty-four samples is recognized as sufficient. Putting the sample size of this study in relation to the sample size from Todd, McKeen and Gallupe (1995) and Haldin-Herrgard (2003), this study uses 100% of the proportional sample size compared to the study from Todd, McKeen and Gallupe (1995), respectively 381% of the sample size from Haldin-Herrgard (2003). The sample size of eighty-four job advertisements is a share of 26,4% from all 318 potential samples.

Since the quantity of available job advertisements for each salary group is different, the application of a lawnmower approach of 26,4% to each salary group to meet the sample size of eighty-four, outgoing from the sample size of 318, would lead to a disbalance between the quantity of samples (int. job advertisements) in each salary group. The salary group EG14 is six to eight times bigger than the other three salary groups. Therefore, the researcher of this study decided to balance the total sample sizes among all salary groups. As calculated above, twenty-one job advertisements for each salary group was defined as target. The number of job advertisement per year was done on a percentage approach according to the original split of the 318 job advertisements. Back to the list where every job advertisement ID is linked to an MS Excel generated random number and sorted from small to big. The researcher identified the samples for each year and each salary group by applying the total number of samples (Table 6) for each category by starting in each category with the job advertisement linked to the smallest MS Excel random generated number.

Table 5 below shows an overview of the total quantity (318) of internal jobs advertisement broken down into salary groups and calendar-years. Table 6 displays the percentage share for each category to balance the number of samples in each category. Table 7 shows the sample size of each category after balancing the total sample size to twenty-one samples in each category (EG13 to LL6) to meet the overall-total sample size of eighty-four. Find in the appendix the random list of identified job advertisements (See Appendix 4).

Table 5: Job advertisements in the PDD (EG13; EG14; AT; LL6)

Job advertisements in the PDD (EG13; EG14; AT; LL6)				
	Years			
Salary Group	**2015**	**2016**	**2017**	**Total**
EG13	3	9	16	**28**
EG14	42	74	105	**221**
AT	9	10	11	**30**
LL6	13	11	15	**39**
			Total	**318**

Table 6: Percentage share to balance the number of samples per category

Job advertisements in the PDD (EG13; EG14; AT; LL6)				
	Years			
Salary Group	**2015**	**2016**	**2017**	**Total**
EG13	10%	33%	57%	**21**
EG14	19%	33%	48%	**21**
AT	29%	33%	38%	**21**
LL6	33%	29%	38%	**21**

Table 7: Total numbers of samples in each category

Twenty-one samples for each category				
	Years			
Salary Group	**2015**	**2016**	**2017**	**Total**
EG13	2	7	12	**21**
EG14	4	7	10	**21**
AT	6	7	8	**21**
LL6	7	6	8	**21**
			Total	**84**

4.4 Ethical considerations

Ethical considerations are presented throughout the research process, especially where sentient existence involved. Up front, these considerations can be perceived as barriers or challenges to the research project, but perceived and navigated correctly, they can also be enablers, helping create a supportive environment (Bryman and Bell, 2015). Toward the creation of a supportive environment, the study researcher undertook specific ethical evaluations for each research step in this project. This process was accompanied by the Humanities, Arts and Social Sciences Research Ethics Committee of the University (HASSREC) and the HR department of the manufacturer. As a basic requirement for project approval by the University, a completed and approved HASSREC application was required for each research step. The application requires the researcher to provide a list of steps, and insightful consideration of potential ethical concerns throughout the process.

Confirmation for ethical approval from HASSREC (See Appendix 10) was received for both research steps. The approval process ensures that risk for unseen ethical conflicts or concerns is low when the researcher adheres to the steps presented.

Since the HR department of the manufacturer required briefing on the research steps to be undertaken by the researcher, the ethical approval process was also made transparent to the HR department of the manufacturer. The comprehensive nature of HASSREC ethical approval process also inspired confidence and trust in the manufacturer´s HR department, which lead to the departments relatively swift approval of the projects process to begin.

Research step one is focused on data collection from organisation-internal sources (job advertisements); research step two is focused on gaining insight via semi-structured interviews with knowledge workers in the organisation. The researcher assessed the likelihood of ethical issues for research step one as low. The focus in research step one is on an appropriate handling of the data gathered during the analysis of the internal job advertisements. The key ethical challenges were identified by the researcher in the interaction between the participants and the researcher during the interview process. The ethical considerations the researcher carried out to avoid any ethical concerns were structured according to four fields in ethics in which transgressions occur (Diener and Crandall, 1978):

- Harm to participants
- Invasion of privacy
- Lack of informed consent
- Deception.

Diener and Crandall (1978) categorize risk of harm to a participant using terms such as stress, physical harm, harm to development or self-esteem, harm to the career prospects, and future employment of the participant. Physical harm to participants in this research is strongly rejected by the researcher. The idea of this research is not related to any kind of performance judgement of the participant. Therefore, the risk of stress to the participant related to data gathering or interpretation of data or the risk of any kind of negative impact on the development and career of the participant is seen as highly unlikely. The collected data is not related to sensitive privacy characteristics of the participants, so invasion of privacy is not a concern. This research project follows the ethical requirements of the HASSREC and those of the manufacturer. As explained above, content and actions of this research project were introduced to both institutions. Harm to non-participants as explained by Gorard (2002) is not foreseen in this project by considering requested ethical requirements of both institutions.

Deception in any form is strongly rejected by the researcher. Transparency helped to generate acceptance for this research project in the environment of the researcher and supported the researcher in dealing with power and privilege that an insider researcher could face. Mercer

(2007) foresees power relation issues of an insider researcher only when the researcher is in a higher ranked position over the interviewee. The researcher in this research project does not have any leadership responsibility or subordinate employees. Seen from this perspective, the position of the researcher is non-conflicting or non-competing. Therefore, power-related issues do not occur. The potential risk of harm to company reputation as a result of revealing the company's identity in the research is small. There are currently more than five multinational automobile manufacturers with development sections in Germany. The described similarities between organisations support the anonymisation of the enterprise in which the research project took place. Additionally, it avoids identification of the concerned enterprise as described by Alderson (1998), Crow and Wiles (2008) based on unique characteristics of the enterprise, but without the risk of changing the meaning of the results by adjusting the context for the sake of anonymisation as highlighted by (Kaiser, 2009).

All data gathered are handled according to the official data protection guidelines. While all the data from the internal job advertisements and the results of the analysis are stored on an access-protected external hard disk, the data gathered during the interview are handled differently. Personal data gathered during the interviews, like name of the participant, age, gender, department and name of the job position, were linked to the participants ID which was generated as explained above. The data that links the participants name to the participants ID was stored (on an access protected USB stick) separately. This means the responses from the participants on the interview questions were tracked only under the generated participants ID and stored separately from the above-mentioned USB stick. Therefore, no direct linking between the participants names and the data gathered during the interview is possible, an approach which guarantees anonymity of the participant. A security backup of the data stored on the external hard disk was done on a monthly basis. The security backup itself was stored on a different external, password-protected data device, which is physically stored in a safe owned by the researcher himself. Data analysis of the collected data in both research steps was done within the described digital framework. The duration of data storage will be as long as the project is in progress and the data will be kept for up to ten years after the project ends in 2020. The date for irreversible destruction of data on all data storage devices is January 2030.

Summarized it can be stated that the researcher followed the ethical guidelines of the HASSREC and the manufacturer. The above-described path is the pattern for doing so, thus insuring professional and academic integrity, inspiring a climate of trust, and winning the support of the participants and stakeholders involved in this research project.

4.5 Process reproducibility and reliability of the results

The following paragraphs describe the actions the researcher carried out to test stability and reliability of the data gathered and the method of data gathering used in the context of this thesis. Krippendorff (2013) states that, in terms of reliability of content analysis, three different types of reliability criteria are useful to apply to content analysis approaches. Krippendorff (2013) distinguishes between stability, reproducibility and accuracy. Stability describes the level to which a process is stable by changing variables of the process, which asks will the same coder achieve the same results in the process by different tries. Reproducibility addresses the degree to which a process can be reproduced and achieve the same results by different coders or at different places. Accuracy is, according to Krippendorff (2013), the strongest reliability test. Accuracy is given when the process of data gathering conforms to an existing standard. The researcher advanced an existing method - developed by Haldin-Herrgard (2003) - in a new context to generate new insights to the phenomenon tacit knowledge. In this new context no expert knowledge or given standard is available. Based on the lack of standard in the new context and the explorative character of this research, valid accuracy testing cannot be conducted in this context.

After finalising the quantitative manifest content analysis for each year and each salary group, the exercise was repeated by the researcher. The results of the first run of the quantitative manifest content analysis and the results of the second run of this content analysis were 100% equivalent. No deviations in the results for each salary group in each year were found. The analysis results of the second run match the analysis results of the first run of data gathering, hence the coding in this thesis is judged as stable (Weber, 1990; Stemler, 2001; Krippendorff, 2013). In terms of stability, it can be stated that the data collected in this data gathering are regarded as reliable.

To prove reproducibility of the coding process in this data gathering exercise, the researcher introduced a colleague familiar with the research project and the internal job advertisements of the enterprise to the coding instructions. The purpose was to test the reproducibility of the coding by having a second coder code the analysed samples. Kolbe and Burnett (1991, p. 248) state that “interjudge reliability is often perceived as standard measures for research quality”.

In the following writing, the researcher in this research references his colleague as coder two. The circumstance that coder two is familiar with the research project itself and also familiar with the internal job advertisements of the enterprise, helped reduce the time for introduction of coder two to the research project itself and the coding instructions for the quantitative manifest content analysis of research step one. Coder two has a master’s degree in business administration and is familiar with the method of quantitative manifest content analysis. These

personal characteristics of coder two helped reduce the training time for coder two to 1.5h. The coding instructions were handed out in written form from the researcher to coder two. The coding instructions guided coder two in the analysis of the job advertisements. Before coder two got access to the samples (internal job advertisements), coder two was briefed of the data security guidelines related to this research project. A copy of the data security guidelines of this thesis were handed over to coder two. Coder two signed a form which said that he read, understood and follows the data security guidelines of this research. A training run of one sample for each salary group was conducted. In this training run, coder two tested to apply the coding rules and tested the way of recording the data in the given tables for each year and each salary group. The agreement level of the total number of used epitomes per internal job advertisement over the four samples used in this training run was seventy-five percent, meaning three of four job advertisements were equally rated. The deviation in the results of one job advertisement was based on an overlooking issue of one ETK by coder two. The handling of the tables to record the data of the coding was, according to coder two, simple and clear. In a question-and-answer meeting between coder one and coder two no issues were recognized. To achieve strong explanatory power, the researcher of this thesis decided to use the full sample size as the set of units to test reliability. The coding from coder two was conducted over a period of two weeks. No issues arose in the coding process. The records from the results of coder two were compared to the results of coder one. The results of the two-coder model showed that the coders produced a coding pattern agreement level of 98%. The difference in the agreement was due to an overlooking issue (epitomes were overlooked and not counted) by coder two. Affected job advertisements were reviewed and coder two was informed of the reasons behind the disagreement in the results. It must be emphasized that this thesis is not the execution of a statistical analysis: it is rather quantifying data. Content validity of the data gathering process conducted in this thesis builds on the argument that the method from Haldin-Herrgard (2003) used in this step of data gathering is known and accepted in science (Heale and Twycross, 2015). The circumstance that the from Haldin-Herrgard (2003) identified ninety-two epitomes as categorical variables were used as the coding units in this content analysis enables the researcher to do a percentage agreement analysis to test reliability of the quantified data (Lombard, Snyder-Duch and Bracken, 2002). Furthermore, the coding rules of this quantitative manifest content analysis are a guarantee for a quantitative approach of data gathering meaning the process of coding did not contain a range of possible answers, any needs for interpretation, ratings, or judgements. The units to count were clearly defined and the exercise was to count the appearance of these coding units in the job advertisements. The quantitative character of this data gathering exercise, the sample size itself, and the non-statistical approach of this thesis makes it unnecessary to apply statistical

math to the data of this thesis. Hence considering the possibility of the agreement occurring by chance as part of a statistical reliability test is not constructive.

Nevertheless, calculating Cohen´s kappa, which according to Stemler (2001), Lombard, Snyder-Duch and Bracken (2004) is widely used and accepted, the interrater reliability coefficient is 0,98 (see Appendix 7). Judging the Cohen´s kappa of 0,98 with generalized scores for Cohen´s Kappa, it can be stated that the level of agreement is rated as “almost perfect” (Landis and Koch, 1977, p. 165). Putting the result of 98% agreement level into the context to the calculated Cohen´s kappa of 0,98 demonstrates the height of the percentage agreement level in this comparison. Comparing the Cohen´s kappa of 0,98 to generalized classifications of Krippendorff´s Alpha, where the coefficient 0 stands for perfect disagreement and 1 for perfect agreement, the result is very close to the perfect agreement rating (Krippendorff, 2013, p. 241). Further conducted statistical measures in the field of research on tacit knowledge underpin the high quality of the research data induced through an agreement level of 98% or a Cohen´s kappa of 0,98. In a study to investigate the effect of tacit knowledge on firm performance , Harlow (2008) used Cronbach´s Alpha to prove interrater reliability between different group ratings. The approach was statistically-based and resulted in an interrater reliability of 0,98. Harlow (2008) defined this as high degree of interrater reliability. Ryan and Connor (2009) have declared an interrater reliability Cronbach´s coefficient of 0,71 in a study of measuring team tacit knowledge in software development as acceptable. According to Lombard, Snyder-Duch and Bracken (2004), there is no general recommendation in science to use a specific approach of proving interrater reliability so the author of this thesis combined two widely used techniques (percentage agreement level and Cohen´s kappa) to demonstrate interrater reliability of the results of this step of data gathering. Comparison to other existing coefficient have underpinned the reliability of the results in this thesis. The actions in terms of demonstrating reproducibility of the process and reliability of the collected data conducted in this research, lead to the result that the process of data gathering is reproducible and collected data can be regarded as reliable.

4.6 The findings of research step one

The following sub-sections describe the single steps of the manifest content analysis applied to the internal job advertisements in research step one and outline the related findings. This data analysis is carried out on two levels.

The first level describes the analysis of the overall results in uses of epitomes. The results of the analysis show the differences in tacit knowledge usage between knowledge workers in different salary groups. These elicited differences are used to identify the salary group of knowledge workers that might possess the greatest amount of tacit knowledge and building from this group the critical resource cohort. ‘Tacit knowledge‘ is an uncountable noun phase

whose amount is spoken of with quantity words such as ‘a little,’ or ‘a lot.’ When analysed using the ETK, the once-uncountable concept becomes countable using terms such as items or epitomes, in turn, allowing ranking by countable number of applied epitomes. Using such a quantified ranking by countable amount of epitomes used, a critical resource group can be easily discovered.

The second level is a deeper investigation with respect to types of epitomes used in the job advertisements for each position. This approach starts on the “surface” of the data and digs deeper into the data and the world behind it. This analysis is used to identify tacit knowledge in the form of ETK frequently used in the PDD. Tacit knowledge forms frequently used in the PDD are understood as highly sensitive to the organisational performance.

The result of these two levels of analysis - the identification of knowledge workers with the highest amount of tacit knowledge and the identification of tacit knowledge in the form of ETK frequently used in the PDD - building the foundations for research step two in this thesis. The following subsections present the findings in detail.

4.6.1 Stability of the raw data

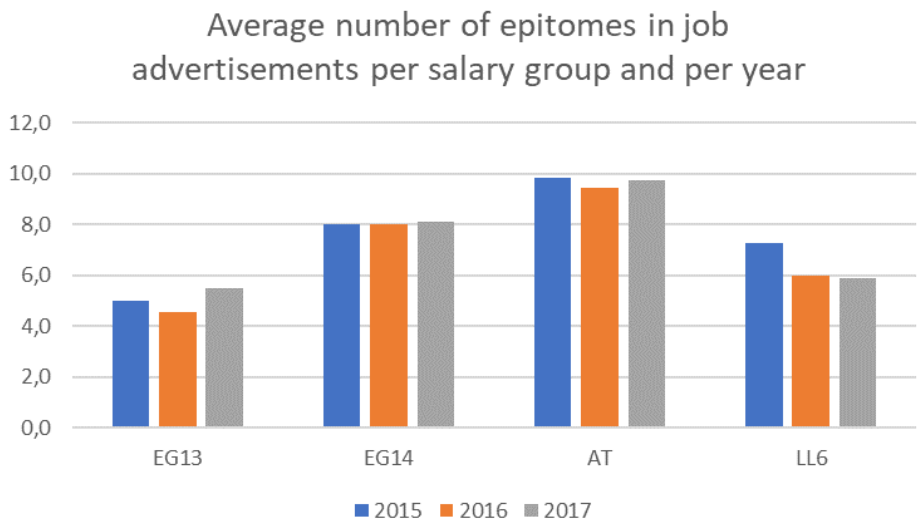
The following paragraphs describe the results of data gathering in research step one. Before the data was further processed, an analysis of the data took place in this section to prove stability, starting with description of the raw data results for each year, each salary group, and overall years for each salary group. The table 8 below summarizes the average frequency of the total number of used epitomes (without giving the granularity of the differences in the use of ETK) for each year in each salary group and a total average for each salary group overall years. For the purpose of proving stability of the overall data, it is not necessary to breakdown the number of the used ETK into the different types of used ETK.

Table 8: Average frequency of used epitomes in internal job advertisements

	2015	2016	2017	Total average
EG13	5,0	4,6	5,5	**5,0**
EG14	8,0	8,0	8,1	**8,0**
AT	9,8	9,4	9,8	**9,7**
LL6	7,3	6,0	5,9	**6,4**

The y-axis in the figure 4 below shows the average number of used epitomes in a job advertisement. The x-axis shows the different salary groups grouped into the different years. The average numbers of epitomes per salary group between the different years are stable.

Figure 4: Average number of used epitomes in job advertisements per salary group and per year



The scatter diagrams in figure 5, 6, 7 and 8 below summarise the analysis of the collected data with respect to the single results of the numbers of epitomes identified in each of the job advertisements within the different salary groups. The following data sets of the individual salary groups all show an average deviation from the median of plus / minus one epitome, meaning more than three-fourths or 79% of all data points are within this corridor of deviation. This result, demonstrates, on a very deep level of analysis the stability of the collected data. The y-axis shows the number of used epitomes identified in a job advertisement. Each blue dot on the x-axis stands for one analysed job advertisement and represents the total number of identified epitomes in the related job advertisement.

Figure 5: Results of the content analysis EG13

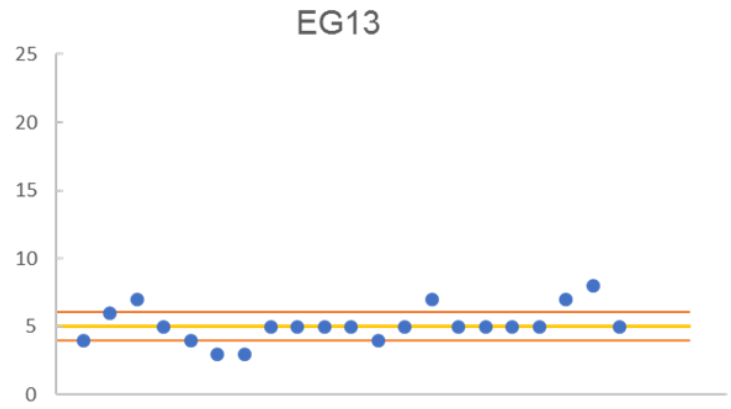


Figure 6: Results of the content analysis EG14

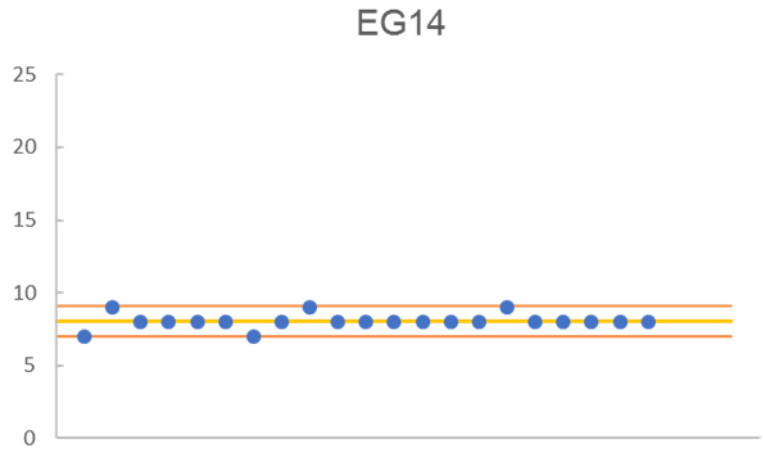


Figure 7: Results of the content analysis AT

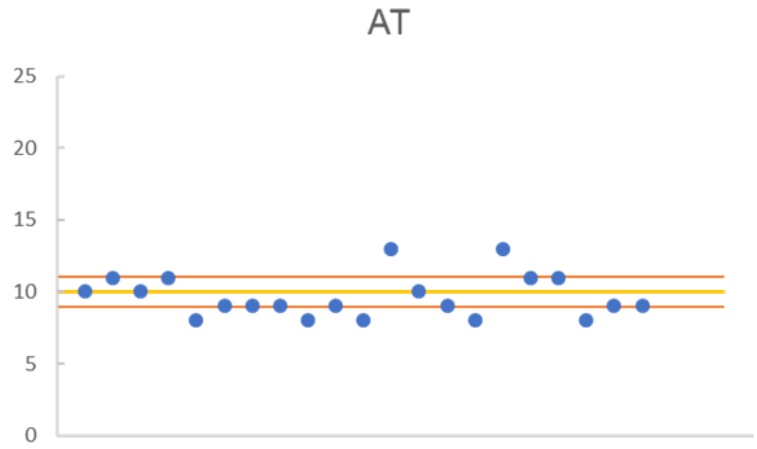
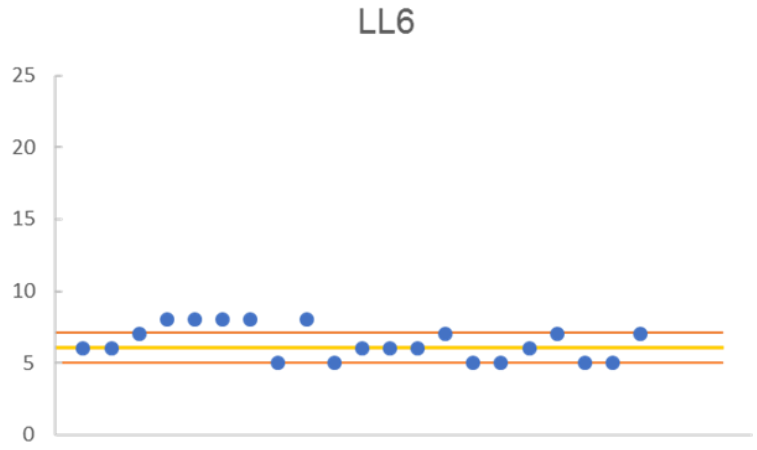


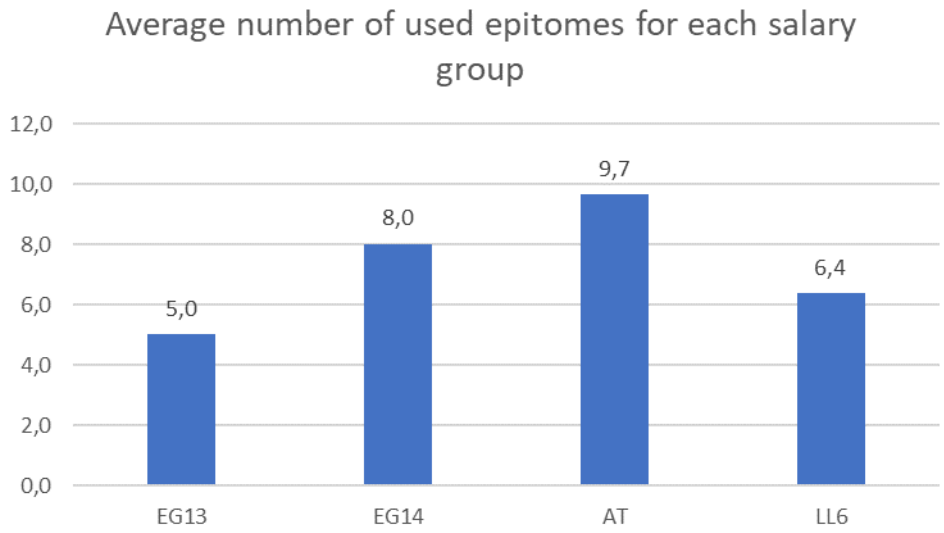
Figure 8: Results of the content analysis LL6



4.6.2 Analysis level one - The amount of required tacit knowledge for each salary group

This analysis of the data gathered in research step one was conducted to unearth the possible need for tacit knowledge in different positions of the organisation and with this to identify the salary group of knowledge worker with the highest amount of tacit knowledge usage. Job advertisements of four different salary groups were investigated with respect to the total number of used ETK. The investigation showed a clear variation on the number of used epitomes between those four salary groups. The variation of the number of used epitomes are an indicator for the use and the organisational demand of tacit knowledge, necessary to perform in the positions for each salary group. The average number of used epitomes for the salary group EG13 is 5, for EG14 is 8, for AT is 9,7 and for LL6 is 6,4. The figure 9 below presents the average number of used epitomes for each salary group. The y-axis shows the number of used epitomes. The x-axis shows the results of the analysis for each salary group.

Figure 9: Number of used epitomes for each salary group



The salary group AT is the salary group with the highest number of used epitomes (9.7). The number of used epitomes correlates with the amount of tacit knowledge necessary to perform in positions in this salary group. A correlation which is proved by the methodology from Haldin-Herrgard (2003). If the researcher of this thesis refers in the following writing to the amount of tacit knowledge identified in a position related to a salary group, this statement is based on the identified number of used epitomes in the specific salary group. So, the phrases “number of used epitomes” and “the possible amount of tacit knowledge” are interchangeable for both directions. The result of the number of used epitomes from salary group AT is followed from the salary group EG14 / (8), LL6 / (6,4) and EG13 / (5). According to the results displayed above, the demand for tacit knowledge in the salary group EG13 is (5), the lowest number of used epitomes, also the lowest demand for tacit knowledge. The salary groups in figure 9 above are sorted by income. Starting on the left with EG13 as the lowest income level and ending on the right with LL6 which is the first leadership level in the organisation and the highest income level of these salary groups. The bar chart in figure 9 shows an increase in the number of identified epitomes from the salary group EG13 up to AT and then a drop of the numbers of used epitomes for the salary group LL6 meaning there is a continuous increase in the number of used epitomes and with this the need of tacit knowledge in the salary groups from EG13 up to AT. For the salary groups EG13 to AT it appears that there is a positive correlation between the level of income and the need for tacit knowledge. This trend is interrupted by the amount of tacit knowledge required for the salary group LL6. The salary group with the highest income level requires, according to the number of identified epitomes, more tacit knowledge than the salary group EG13 but less tacit knowledge as the salary group EG14. The next section starts with an explanation on the trend breaking result for the salary

group LL6 with respect to the amount of required tacit knowledge to perform successfully in this position.

4.6.3 The possible impact of job roles and responsibilities on the demand of tacit knowledge for specific positions

The declining number of used epitomes for a LL6 job advertisement in comparison to the continuously increasing number of epitomes from the salary levels EG13, EG14 and AT is striking. A striking anomaly in the straightforward income-increasing trend the result might be explained by the different roles and responsibilities of each salary group. The roles and responsibilities for the salary groups EG13 and EG14 as part of the collective labour agreement are clearly defined by a committee consisting of the labour union and the employer´s representative. The organisation, in cooperation with the working council, developed a job description for each job (Appendix 6). A job description is related to a specific job type within a specific income level. A job type can be related to different positions. For example, the job type “engineer” can be located in different positions of an organisation. A job description describes on a holistic level the roles and responsibilities as well the character of a job type within a specific salary group. In contrast, a job advertisement describes in detail the roles and responsibilities as well the required competence related to a specific position in a specific section of the organisation. A job advertisement is based on an official job description. Comparing job descriptions to each other helps to neutralize the effect of specific position requirements by comparing the differences in role and responsibility between the different salary groups on a holistic level.

From a review of the company’s internal job descriptions it can be summarized that an EG13 worker has to execute tasks or actions and to support different actions within the development process as instructed by a supervisor (LL6). The internal job description is a picture of the roles and responsibilities which is in line with the different descriptions of the field of actions within the analysed internal job advertisements. The job description for positions within the salary group EG14 shows that the core business in such a position is to generate knowledge, to develop parts, to execute different tasks given by the management and to exchange information with different teams in the development section of the enterprise. EG14 workers are autonomous workers. The job descriptions of an EG14 position clearly requests the need for decisions and performance on a self-depended / autonomous level. The request to a worker to act mostly independent / autonomously in a EG14 position is a major distinguishing factor of the EG14 job description compared to the job description of a EG13. According to Scarbrough (1999) worker autonomy and a low level of boundaries are typical characteristics of a knowledge worker. As already described above, tacit knowledge, according to Blackler (1995) and El-Farr (2009) is the type of knowledge which enables a knowledge worker to

perform successfully in his position. When independence / autonomy of a worker is a criterion which is, according to Scarbrough (1999), strong enough to identify knowledge workers and knowledge workers according to Blackler (1995) and El-Farr (2009), deal mostly with tacit knowledge, it can be deduced that there is a linkage between independence / autonomy of a worker and tacit knowledge. This statement can be underpinned by an explanation of the role of tacit knowledge from Haldin-Herrgard (2004). Haldin-Herrgard (2004, p. 14) stated that tacit knowledge affects the ability to act independently, which clearly highlights interdependences between autonomy of a worker and tacit knowledge. Putting this in context to the results of the analysis means that the degree of autonomy / independence, required from a worker to perform successfully in his position, can be seen as an explanation for the difference in the amount of required tacit knowledge between an EG13 and an EG 14 position.

Due to the fact that AT positions are not part of the classical labour contract, no specific job descriptions has been developed. A code of practice for the AT position was developed in cooperation between the labour union and the employer´s representative. This code of practice shows that AT positions are more specialized positions. The AT level is a level of experts and specialists. AT employees are managing challenges which are requiring more specialized qualifications than those were defined in the job descriptions for EG13 or EG14. The majority of AT level employees do not have a leadership role (IGM, 2015) in the definition of the roles and responsibilities which matches descriptions of the field of actions within the analysed internal job advertisements. AT level employees have a high level of expertise in specific fields of the development process and are responsible for generating knowledge, for supporting other colleagues by sharing their knowledge, for advising colleagues by sharing their expertise and for identifying efficiency opportunities to improve business. Compared to the positions EG13 / EG14 they have an even broader field of independence and autonomy. The circumstance that once a year each AT worker has to define its own performance objectives as baseline for personal performance, judgement underpins even more the level of autonomy an AT worker owns. In general, it can be stated that the level of autonomy, expertise, and specialisation increases from salary level EG14 to AT. The distinguishing level of independence and autonomy of an AT-level worker compared to an EG14-level worker might deliver in this comparative analysis the explanation for the increase of required tacit knowledge from the EG14 to AT. A further differentiating finding in this comparative analysis was the level of expertise and specialisation of an AT-level worker versus an EG14-level worker (IGM, 2015). Specialisation and expertise are key attributes of an highly experienced employee and recognized in the context to tacit knowledge. Drucker (2002) stated that the main capital of a knowledge worker is only effective when it is specialised. Davenport (2005) describes a knowledge worker as a worker with a high degree of expertise. Haldin-Herrgard (2003) identified the epitome “expertise”. Requesting expertise as in the job posting is linked with the

use of tacit knowledge. Considering, as described above, that the use of tacit knowledge is crucial for knowledge worker and that expertise is linked to tacit knowledge, it can be deduced that the level of specialisation and expertise has interdependencies with the use of tacit knowledge. Hence the analysed increase in the level of expertise and specialisation required to perform in an AT position versus an EG14 position has to be considered as further reason for the difference between these positions in the amount of required job-related tacit knowledge.

Looking for possible explanations on the drop of used epitomes for LL6 workers starts with the responsibilities of an LL6 worker. For LL6 positions there are no general job descriptions available in the organisation. Summarizing the described roles and responsibilities of an LL6-level employee based on the review of the descriptions of the field of actions within the analysed internal job advertisements and neutralizing positions-specific characteristics, the core responsibility of an employee in the Leadership Level 6 (LL6) is to lead. Generating knowledge is not a primary responsibility. A leader has to ensure that the business follows the direction from the higher management. The primary responsibility is leading subordinated employees in the way to make the company successful reporting results to management, and distributing tasks from management to the team. LL6 employees link management with the team.

Summarizing the findings of this first level of data analysis in data gathering step one, it can be stated that the level of autonomy of a worker in his position and the level of specialization / expertise based on gained experience do have an effect on the amount of required tacit knowledge in a position. The comparative review of the job descriptions from EG13 to AT and the data analysis level 1 in step one of data gathering showed the more autonomy and specialisation of a worker to perform in his position is required, the higher is the demand for tacit knowledge in the related position.

4.6.4 Analysis level two - The scatter of specific epitomes for each salary group

The total number of identified epitomes over all salary groups and years used in the job advertisements is 614 (Table 9). Breaking down the results of step one data gathering into the specific types of used epitomes in this context, ten epitomes emerge as the most frequent of the ninety-two existing epitomes identified by Haldin-Herrgard (2003). The total range of ninety-two epitomes does not represent a specific domain nor specific context. As explained above, the ninety-two epitomes are the result of an extensive literature review carried out by Haldin-Herrgard (2004) and containing every possible epitome of tacit knowledge. Hence the range of used epitomes narrows the variables and characteristics linked to the specific context. Table 9 shows the breakdown of the ten most frequently used epitomes identified in this specific context for each salary group:

Table 9: Summary of ETK usage in the PDD job advertisements

	Epitomes of tacit knowledge										
	Knowledge base	Experience	Expertise	Ability	Skills	Creativity	Talent	Techniques	Capabilty	Understanding	Total number of epitomes per salary
EG 13	1	13		26	56	1	1	1	1	8	**108**
EG 14		52		27	74	5	2	5	3	1	**169**
AT		46	2	23	98	2		9	12	11	**203**
LL6		58	1	29	36					10	**134**
Total	**1**	**169**	**3**	**105**	**264**	**8**	**3**	**15**	**16**	**30**	**614**
Share from total number of epitomes	**0,2%**	**27,5%**	**0,5%**	**17,1%**	**43,0%**	**1,3%**	**0,5%**	**2,4%**	**2,6%**	**4,9%**	

This narrowed range of ten epitomes used in this context from the total range of ninety-two existing epitomes, demonstrates the context relation of tacit knowledge which is verbalised from the majority of authors in the field of tacit knowledge research (Polanyi, 1966; Nonaka and Takeuchi, 1995; Ford and Sterman, 1997; Johannessen, Olaisen and Olsen, 2001; Gourlay, 2003; Gascoigne, 2013). Of the ten types presented in Table 9, three epitome types – Skills, Experience, and Ability – represent almost 88% (538 epitomes) of application in job performance. Table 10 below shows the extracted types of concentrated total usage frequency and the percentage share from the amount of all epitomes for each of these three epitomes.

Table 10: Most used ETK over all job advertisements

Epitome	Frequency of usage	% - Share from Total Number
Skills	264	43%
Experience	169	28%
Ability	105	17%
Total	**538**	**88%**

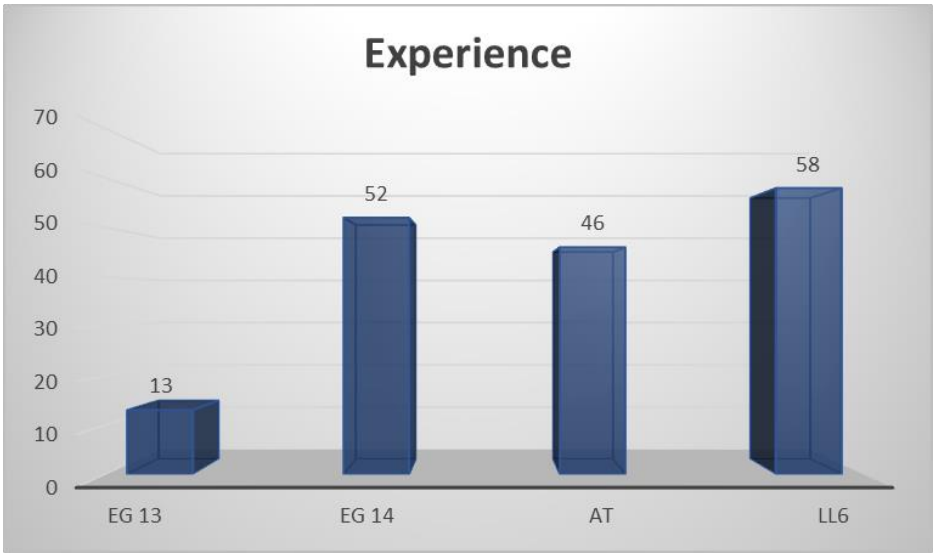
Therefore, further investigation concentrates on deeper analysis of frequently used tacit knowledge in the form of skills, experience and ability.

With a share of 43%, “skills” is the most used type of ETK. It was used 264 times across all salary groups and years. A continuously increase was identified in the frequency of usage from EG13 to AT and a significant drop in the frequency of usage for the LL6 position. LL6 is the salary group with the fewest number of the epitome skills. AT is the salary group with the highest frequency of use for this epitome. See the figure 10 below:

Figure 10: Frequency of usage for the ETK "Skills"

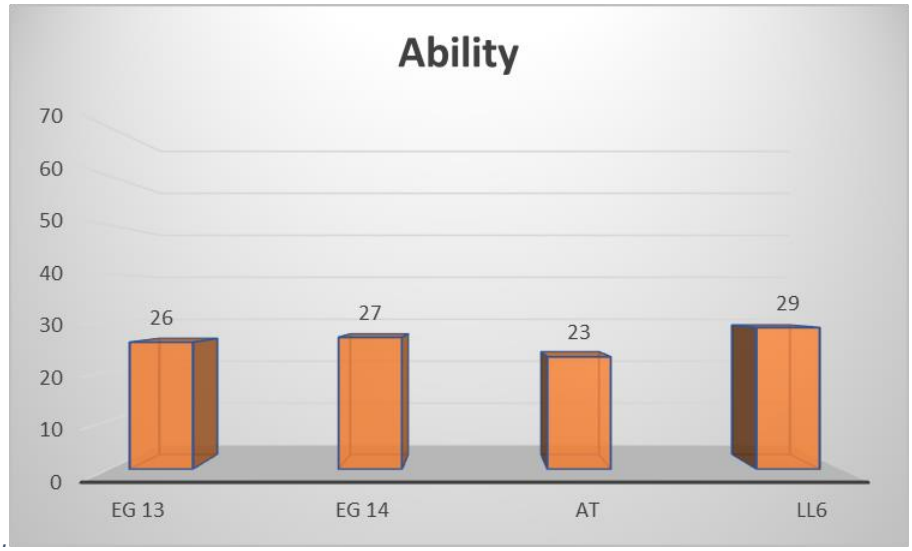
The ETK “experience”, with a share of 28%, is the second most often used type of epitome. It was used 169 times across all salary groups and years. In job advertisements for the salary group LL6 was experience 58 times used followed by EG14 with 52 times, and AT with 46 times. A significant drop in the frequency of use of this epitome was identified for the salary group EG13 (13 times) meaning the epitome experience for the salary group EG13 is on average 75% less often used as for all other salary groups. See the figure 11 below:

Figure 11: Frequency of usage for the ETK "Experience"



The share of the ETK ability from all used epitomes is 17%. Ability was mentioned in total 105 times over all salary groups and years and ranks as the third often used ETK. Between the single salary groups, no significant deviation in usage of this epitome was recognized. For the salary group LL6 compared to the other non-leadership salary groups was the epitome ability most often used. See the figure 12 below:

Figure 12: Frequency of usage for the ETK "Ability"



Based on the results of analysis level 2 it can be summarized that tacit knowledge in the form of ETK is frequently used in the form of skills, experience and ability. The in the distribution of the ETK skills and experience between the different salary groups variation is high. The ETK ability does not have these big variabilities between the individual salary groups. Tacit knowledge in the form of abilities exists in a rather homogenous amount in all four salary groups. The risk of losing tacit knowledge in case of increased employee retirement loss in the form of skills, experience and abilities is due to its frequently usage in the PDD most likely. Losing these frequently used specific tacit knowledge forms will have a significant impact on the performance of the PDD.

There is a significant use of the term “skills” and the term “experience” in literature on tacit knowledge. From the majority of authors skills is used to define and explain tacit knowledge (Polanyi, 1966; Nonaka and Takeuchi, 1995; Fleck, 1996; Sparrow, 1998; Leonard and Sensiper, 1998; Nonaka and Konno, 1998; Ambrosini and Bowman, 2001; Howells, 2002; Haldin-Herrgard, 2004; Seidler-de Alwis and Hartmann, 2008; Siesfeld, Cefola and Neef, 2009; Holste and Fields, 2010; Gascoigne, 2013; Jafari, Akhavan and Nourizadeh, 2013). According to Ashton and Green, (1996) skills are individual attributes closely related to ability, which explains why tacit knowledge in the form of abilities and skills occurred together as most frequent used specific forms of tacit knowledge in the PDD. Furthermore the majority of authors state that the use of tacit knowledge is experience related, based on experience, out of experience, or linked to experience (Polanyi, 1966; Nonaka and Takeuchi, 1995; Saint-Onge, 1996; Nonaka and Konno, 1998; Gore and Gore, 1999; Zack, Rand and Wilsh, 1999; Johannessen, Olaisen and Olsen, 2001; Gourlay, 2004; Haldin-Herrgard, 2004; McAdam, Mason and McCrory, 2007).

The circumstance that skills and experience are frequently used from authors in the field of tacit knowledge to explain or define tacit knowledge underpins the validity of the results of research step one. According to these results, further investigations to more deeply explore tacit knowledge in the form of skills, experience and ability and its contextualisation in this organisation is considered as most promising to achieve deeper insights on tacit knowledge usage in the PDD.

4.7 Summarizing the results from research step one to answer RQ1 and RQ2 and to establish the research direction for research step two

The stability of the collected data was proven by a second run of the coding carried out by the researcher. No deviations from the first run of coding versus the second run of coding were identified. Therefore the process of data gathering was rated as stable.

A second coder was involved in proving reproducibility of the process of data collection and reliability of the collected data. The percentage agreement level between the results from coder two versus the results from coder one was 98%. Cohen´s kappa coefficient was calculated with 0,98. Based on these results the reproducibility of the process of data gathering was proved and with this the collected data are regarded as reliable.

Total averages of used epitomes for each salary group over all years were displayed. The AT salary group was the salary group with the highgest average of used epitomes (9,7) followed by EG14 (8,0), LL6 (6,4) and EG13 (5,0). Hence knowledge workers of the salary group AT were identified as crititcal resources in the event of employee loss because these knowledge workers demonstrate the highest amount of tacit knowledge usage in the PDD. To investigate the level of accuracy a further analysis of each single data set was carried out. The analysis of the result for each single set of data showed the average deviation from the median for each salary group. More than three-fourths or 79% of all data points are within a standard of deviation of about minus / plus one epitome. A result that demonstrated on a deep level of analysis, the stability of the collected data. Subsequent to these analyses, the researcher analysed existing job descriptions related to the samples of the salary groups. The aim was to identify the distinguishing characteristics with respect to the variables between the different salary groups. Based on this analysis, an explanation of the differences between the uses of tacit knowledge for the different salary groups was created. A continuous increase of required employee autonomy and employee specialisation from the salary group EG13 to AT was detected. A rise in employee autonomy and employee specialisation is seen as a possible explanation for the increase in the number of used epitomes and with this for the need of tacit knowledge to perform in related positions between the salary groups EG13 to AT.

A correlation between the level of income and the amount of required tacit knowledge from EG13 to AT is possible, but cannot be regarded as generally valid without additional investigation; these additional investigations are not within the scope of this thesis. Further research in a separate thesis on salary groups lower than EG13 would have to be carried out to explore a possible correlation.

The drop in the number of used epitomes on the salary group with the highest income (LL6) was explained based on the roles and responsibilities of this leading position. The core responsibility of an employee in the Leadership Level 6 (LL6) is to lead and not to generate knowledge. The results from data analysis level 1 made it possible to answer research question (RQ1).

RQ1: How does the usage of job-related tacit knowledge differ between knowledge workers in different positions within the product development department of a multinational automotive manufacturer in Germany?

The data analysis in analysis level 1 of research step one indicated that the requirement for tacit knowledge usage is for an AT worker the highest. Assuming that only a qualified employee who fulfils the formal and personal requirements of the position is employed in such a position, it can be deduced that AT level workers hold the greatest amount of tacit knowledge in this organisation. Based on this result, AT-level knowledge workers are identified as critical resources in the PDD, followed by EG14 level workers, LL6, and EG13 workers. Therefore, knowledge transfer actions in a case of greater employee loss must be prioritized (Priority) for AT level workers. Thus, for efficient resource management, prioritization for knowledge transfer actions between the different salary groups to avoid or to reduce the risk of tacit knowledge loss should be done by using the ranking below:

1. Priority 1 – AT
2. Priority 2 – EG14
3. Priority 3 – LL6
4. Priority 4 – EG13

A further finding of data analysis level 1 is related to the impact of specific job characteristics on the amount of tacit knowledge required to perform in the related positions. A comparative review in analysis level 1 of job descriptions indicated that the more autonomy and specialisation of a worker to perform in his position is required the higher is the demand for tacit knowledge in the related position. Hence the request for high autonomy and high specialisation is linked to a high usage of tacit knowledge.

In analysis level 2 of research step one, the author of this thesis was able to outline the significant deviation in the frequency of usage of the ETK skills, experience and ability. These predominant forms of tacit knowledge were used with a share of 88% in the job advertisements to refer to the use of tacit knowledge. Therefore, tacit knowledge in the form of skills, experience and ability seem to be essential in this organisation. Hence losing tacit knowledge in the forms of skills, experience and abilities would have a serious impact on organisational performance in case of knowledge loss because of greater employee leavings in the PDD. The identification of tacit knowledge in these forms answers research (RQ2).

RQ2: What specific tacit knowledge is frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

Tacit knowledge used by knowledge workers in this organisation is frequently applied in the forms of the ETK skills, experience, and ability. These ETK had a share of 88% of the range of all used epitomes. The researcher was able to define individual insights on the phenomenon tacit knowledge by highlighting interdependencies between employee experience, the level of

employee autonomy, the level of employee specialisation, the range of employee skills and the amount of tacit knowledge an employee uses.

This result shows some similarities to the results from the study conducted by Haldin-Herrgard (2003). In her study, Haldin-Herrgard (2003, p. 105) mentioned these epitomes among the epitomes most commonly used epitomes in her context. Thus, tacit knowledge in these forms seems to have a central role in organisations, but the meaning behind these forms might be different in every context. The similarities between the results from Haldin-Herrgard (2003) and the results of this analysis supports the approach in this thesis to concentrate further investigation on tacit knowledge in these forms. Further exploring skills, experience, and abilities will aid understanding how tacit knowledge in these forms is applied by knowledge workers in the PDD of the case organisation to achieve what purposes.

It can be stated that the data analysis from the first step of data gathering answered the research questions RQ1 and RQ2. The results from the analysis of the data gathered in research step one makes it possible to focus in research step two on the critical variables in the context of tacit knowledge usage in the PDD. The so-called critical variables are employees in the salary group AT who possess the greatest amount of tacit knowledge in the form of the ETK (skills, experience and abilities) frequently used by these workers. These critical variables create the highest risk potential with respect to organisational performance in case of losing them in a great wave of boomer retirements.

Chapter 5: Research step two: Further exploring tacit knowledge usage in the form of skills, experience and abilities in the PDD

This chapter describes the linkage between research step two and the research questions RQ3 and RQ4. An explanation of the theoretical base, the approach itself, the sample characteristics in the second step of data gathering, and the method used to analyse the qualitative data is part of this section.

The research step two in this sequential research builds on the conclusions from research step one. Step two is needed to support the findings from research step one by further exploring the context related meaning behind the application of tacit knowledge in its frequent forms of ETK in the PDD. This enables the researcher to elicit patterns related to the use of tacit knowledge, up to now unknown in the automotive sector. Eliciting these patterns helps to contextualise the usage of tacit knowledge in the form of skills, experiences, and abilities in activities carried out by knowledge workers in its specific context, the PDD. The goal is to generate an understanding of how tacit knowledge in the form of skills, experience, and abilities is applied by knowledge workers in the PDD and for what purposes. The central method of collecting data in research step two is semi-structured interviews deployed with twenty-two AT-level employees as research participants. The AT-level group has been identified as the most critical resource with respect to tacit knowledge possession and use in the case organisation. Applying thematic analysis to the data gathered helps to answer the following research questions:

RQ3: How is specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

RQ4: What is the purpose for the application of specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

5.1 Conducting semi-structured interviews

To further explore the use of tacit knowledge, which is personal, it is necessary to interact with the possessor (Polanyi, 1966; Nonaka and Takeuchi, 1995; Ambrosini and Bowman, 2001; Johannessen, Olaisen and Olsen, 2001; Gourlay, 2003). Having been identified in research step one as possessing the greatest amount of tacit knowledge in the PDD, AT-level knowledge workers are also seen as critical resources with respect to tacit knowledge loss in

a period of greater than usual employee retirement loss. The AT-level knowledge worker is seen as an accessible “intersection” between the researcher and the hidden world of tacit knowledge in the organisation. At this intersection is it possible to further explore the use of tacit knowledge in the form of skills, experience, and abilities in the PDD. Considering the findings in the literature research that interviews are mainly used to elicit tacit knowledge, the use of interviews is identified as an appropriate method to access to the hidden world of tacit knowledge in the form of skills, experience, and abilities in the PDD. Haldin-Herrgard (2003) proved that the use of ETK in an interview increases the ability of the interviewee to articulate tacit knowledge. This can be explained by the circumstance that these self-evident epitomes are daily language terms used when referring to tacit knowledge usage. Hence, ETK are seen as a concept the participants is familiar with, an attribute of the ETK the researcher builds on in the second step of data gathering.

Hammersley and Atkinson (1995, p. 126) have stated that the essential capacity of language is to deliver explanations about any aspects of the world. A statement which even more underpins the approach of the researcher to elicit the phenomenon tacit knowledge by verbal conversation. Face to face exchange of information with respect to the use of tacit knowledge is an opportunity to benefit from the described languages capacity. Epitomes of tacit knowledge become vehicles to enter the knowledge worker´s tacit dimension of knowledge. Because this step of data gathering is a qualitative approach and the researcher was able to use the results of research step one to narrow the themes he wants to explore, the researcher decided to use semi-structured interviews. Structured interviews are mostly based on pre-prepared questionnaires and standardized questions. Structured interviews are predominantly used in quantitative approaches (Denzin and Lincoln, 2008; Gray, 2009; Saunders, Lewis and Thornhill, 2016). Therefore, structured interviews are not compatible with research step two. On the other hand, using an unstructured interview approach in this step of data gathering would ignore the findings from research step one and end up in a broader field which diffuses the results of this thesis. Semi-structured interviews construct an appropriate environment for the use of epitomes and with this, a best fitting data collection tool in this context. By using a semi-structured approach, the researcher is able to narrow the field of exploration to the topics he wants to cover. This is realized by organizing the interview around predetermined, open-ended questions. Other questions called “probing questions” are raised by the researcher during the interviews to achieve a deeper understanding of the context of the answers from the interviewee (Denzin and Lincoln, 2008; Whiting, 2008; Gray, 2009; Saunders, Lewis and Thornhill, 2016). The implementation of the epitome’s skills and experience in the predetermined questions of the interviews, surrounded by mentioned probing questions will help to focus on skills and experiences. The researcher recognized, that there is a common agreement in science about the challenge of eliciting tacit knowledge from an individual. The

biggest challenge to overcome in research on tacit knowledge is supporting individuals in becoming aware of their tacit knowledge for the purpose of verbalising tacit knowledge (Polanyi, 1966; Nonaka and Takeuchi, 1995; Zack, Rand and Wilsh, 1999; Johannessen, Olaisen and Olsen, 2001; Gertler, 2003; Haldin-Herrgard, 2003; Holste and Fields, 2010; Goffin and Koners, 2011; Gascoigne, 2013).

Polanyi (1966) and Nonaka and Takeuchi (1995), three of the most cited authors in the field of tacit knowledge, bring up the point of enabling individuals to verbalise their tacit knowledge. Polanyi (1966) refers to the process of developing an identikit picture. This process describes an interaction between a potential witness and a person who is raising questions to elicit knowledge from the witness in order to be able to create an identikit picture. According to Polanyi (1966) is the described process of interaction the enabler to elicit possessed knowledge from the witness the witness is not aware of. Nonaka and Takeuchi (1995) refer in their SECI Model to the mode of externalization which is triggered by dialogues or collective reflection. This mode stands for the articulation of hidden tacit knowledge by employing metaphors for sharing tacit knowledge with others (Nonaka and Takeuchi, 1995, p. 71). Basically, these authors are describing processes of interaction to enable individuals to externalize via verbalisation their tacit knowledge. Based on this interpretation, the researcher does recognize that verbal face-to-face interactions between individuals are an essential setting for eliciting tacit knowledge. A semi–structured interview facilitates this form of necessary active collaboration between the researcher and the participants, comparable to the identikit picture process and the SECI Model (Douglass and Moustakas, 1985). The next section introduces the basic questions of the semi-structured interviews and their aims with respect to the expected contribution so as to answer RQ3 and RQ4.

5.2 Developing the semi structured interview questions

Conducting a semi-structured interview requires smart preparation of the interview questions, the interview setting and the interview execution. The process behind the creation of the interview questions was based on the mission of research step two, to further explore the context related meaning behind the use of tacit knowledge in the frequent used forms of ETK. Since the ETK identified in research step one establish the central element in the interview questions, the answers are linked to the ETK. By interviewing different participants using the same ETK the likelihood of emerging patterns in the interview data and the description of similar experience or activity related to the ETK is high. The literature research helped the researcher to identify thematic analysis as an appropriate method for eliciting recurring patterns in the interview data and enabling further exploration of tacit knowledge application in the PDD. It has to be emphasized that the identification of an appropriate method to analyse the data had an impact on the creation of the interview questions. To maximize the potential

for eliciting recurring patterns across the ETK and enabling them to reveal the overall story the interview data tells with respect to the common meaning behind each ETK among different positions, the researcher decided to use the same question structure for each ETK. A detailed justification for applying thematic analysis to the interview data follows in a later chapter of this thesis.

The questions used for the semi-structured interview are open questions and carefully worded and structured, starting with a general understanding of skills or experience from the perspective of the participants. This general understanding creates a baseline of the perspective of the participants with respect to their individual interpretation of the ETK before narrowing down to concrete examples out of the participants business context. This specific wording and hierarchy of questions help the participant and the researcher to adjust in their roles and to the topic without losing any important information. The tables 11 and 12 below are divided into questions concerning the ETK skills and questions concerning the ETK experience. Sternberg (1988, 1997) defines tacit knowledge as the practical ability to learn from and to solve problems in everyday life with the aim to achieve a personal goal. From this statement it is deduced that tacit knowledge itself is understood as the essential ability for developing skills or processing experience to handle challenges in everyday life. Hence tacit knowledge in the form of abilities is interwoven with tacit knowledge in the form of skills and experience. Monitoring participants answers to questions during the interview, the researcher is able to focus probing questions to develop a deeper understand of tacit knowledge in the form of ability and its connection to tacit knowledge in the form of skills and experience in specific contexts. Therefore, the ETK ability was not explicitly verbalised in the semi-structured questions below. To achieve the required depth of understanding of the answer given by the respondent, the researcher uses probing questions. Probing questions are responsive follow-up questions which set a specific focus. This helps to achieve a higher granularity of exploration on the phenomenon being investigated (Gray, 2009; Ritchie and Lewis, 2012; Saunders, Lewis and Thornhill, 2016).

Table 11: Interview questions related to the epitome skills

	Question	Aim
Skills	Q1: What meaning has skill to you in your work?	To identify patterns of perception and meaning of skills between the different participants overall positions. This will help to generate an understanding of the participant´s perception and meaning of skills in his or her position.
	Q2: What kinds of skills are required in your work?	To generate an understanding which specific skills are mainly affected / needed in the participant´s position. This will help to understand the commonality or difference with respect to the requirement for specific skills overall participants and positions.
	Q3: Which skills are really important to you and why?	To generate an understanding of the importance of specific skills and the arguments behind the classification of importance. This will help to identify abilities required from a knowledge worker to perform in the PDD and to identify patterns of skills which are classified as really important in the context of the participants between all participants overall positions. The answers will enable the researcher to link specific skills with the use of tacit knowledge.
	Q4: To which of the following activities would you locate your skills in the context to your position and why? (Sensuous, Mental, Social, Practical, Holistic)	To locate skills according to the field of activities defined by Haldin-Herrgard (2003). This will help to define fields of activities in the organisation where skills are related to a high usage of tacit knowledge.
	Q5: How important are skills to the end results of your work?	This question helps to detect any kind of inconsistency to the answers of the questions Q1 to Q3. Perception of inconsistency by the researcher can be an indicator of insufficient understanding of respondent's answers. This question is a chance for the researcher to raise additional questions and to guarantee the right understanding of the answers given from the participants.
	Q6: Can you give me an example of the importance of skills in your work?	To enable the researcher to put the answers from the questions above into the context of this example. This will help to unearth further details on the importance of skills and abilities and the interdependencies between skills and abilities as well the use of tacit knowledge which weren´t detected during the questioning before.

Table 12: Interview questions related to the epitome experience

	Question	Aim
Experience	Q7: What meaning has experience to you in your work?	To identify patterns of perception and meaning of experience between the different participants overall positions. This will help to generate an understanding of the participant´s perception and meaning of experience in his or her position.
	Q8: What kinds of experiences are required in your work?	To generate an understanding which kind of experience are helpful in the participant´s position. This will help to understand the commonality or difference with respect to helpful experience overall participants and positions and to link specific experience with the use of tacit knowledge.
	Q9: In which of the following activities in the context to your position do you gain most of your experience and why? (Sensuous, Mental, Social, Practical, Holistic)	To understand in which field of activities defined by Haldin Herrgard (2003) gained the interviewee most of his or her experience. This will help to identify abilities required from a knowledge worker to perform in the PDD and identifies the activities in the organisation which are linked to high usage of tacit knowledge.
	Q10: How important are experiences to the end results of your work?	This question helps to detect any kind of inconsistency to the answers of the questions Q7 and Q8. Perception of inconsistency by the researcher can be an indicator of insufficient understanding of respondent's answers. This question is a chance for the researcher to raise additional questions and to guarantee the right understanding of the answers given from the participants.
	Q11: Can you give me an example of the importance of experience in your work?	To enable the researcher to put the answers from the questions above into the context of this example. This will help to unearth further details on the importance of experience and the interdependencies between experience and the use of tacit knowledge which weren´t detected during the questioning before.

5.3 Pilot testing of the interview

Three separate face-to-face pilot interviews were conducted. Two men and one woman within the AT pay scale were randomly identified for pilot testing. In pilot interview one it was observed that the initial formulation of interview question Q4 was misleading. This question was wrongly worded with regards to the initial content. The researcher´s aim was to identify the field of activity dominant in gaining experience. This question was reformulated by the researcher during the interview and updated for pilot test two and three. In the pilot tests for participant two and three, the updated question was understood and answered by both participants without further enquiry.

Another observation for improvement during pilot testing one was made as well for interview question Q4 and also for interview question Q9. In interview question Q4 and Q9 the participant was asked to allocate skills and experience to specific fields of activities (sensuous, mental, social, practical, holistic). In the pilot testing with the first participant, it turned out that it was not easy for the participant to remember each provided field of activity while thinking about an answer to this question. Based on this experience, the researcher decided to prepare a one pager which displays each field of activity linked to an icon for visualising the possible activities to the participant (See Appendix 8). This one-pager was used in the pilot testing with the second and the third participant by putting it on the table in front of the participant for Q4 and Q9. By visualising the fields of activities, it was easier for both participants to work with the possible answer options with respect to the field of activities related to skills and experience in their positions. Therefore, the one pager became part of the interview process.

In general, the dialogue between the interviewer and the interviewees flowed. The answers given could be used without any limitations to achieve deeper insights on the phenomenon tacit knowledge. After the interviews were finished, the participants were asked if they had a comfortable feeling during the interview and if the interviewer could somehow improve the conducted exercise. All participants felt absolutely comfortable and hadn´t any suggestions for improvements. On average, each interview slot took one hour. This hour included briefing of the participant to bring the participant into the topic, conducting the interview, and facilitating feedback from the participant and the interviewer in both directions. Preparation before and after the interview took thirty minutes each. Therefore, two hours for the execution and preparation of an interview seemed to be sufficient.

According to Gray (2009), if there are no significant changes in the interview process or the questions applied, then it is not unusual to use the pilot sample data for the final results. The overall positive achievements in this pilot test phase led to the decision by the researcher to include the pilot sample data in the results.

5.4 Sample criteria and sample size for research step two

Because thesis research step two builds on the results from research step one in this thesis and AT-level knowledge workers are identified as critical resources, sampling is limited to these positions in the PDD. Extending the field of samples from AT-level workers only to workers of other salary groups would distract the focus from knowledge workers linked to the highest use of tacit knowledge. This could potentially end up producing inaccuracy in the results. The inclusion criteria for the type of employment was defined with base head employees only. Agency employees are not part of this research. The inclusion criteria for the region of employment was limited to the criteria of the already reviewed job advertisements. Area of employment was limited to the field of organisation (Product Development Department) this research concentrates on. Table 13 below summarizes the criteria of samples which are used as inclusion and exclusion criteria for attending as a participant in this research:

Table 13: Sample criteria for step 2 of data gathering

Stage of data collection	Sample type	Inclusion criteria	Exclusion criteria
Step two of data gathering	Employees of the multinational car manufacturer	Base heads of the multinational car manufacturer	Non-base heads / agencies
		Salary - Level: AT	Deviating to inclusion criteria defined salary levels
		Job experience: > 3 years	Employees with job experience less than 3 years
		Area of employment: Product development department- Merkenich / Cologne	Area of employment: Non-product development department - Merkenich / Cologne
		Region of employment: Germany -> Merkenich / Cologne	Region of employment: Non-Germany -> Merkenich /Cologne

The decision for the number of participants (AT-level employees of the organisation) to be interviewed was based on the sample size Haldin-Herrgard (2003) used in her study and further arguments on sample sizes found in the literature. Haldin-Herrgard (2003) identified twenty-two participants as sufficient in her study. Across the literature a range of ten to sixteen participants is described as sufficient for conducting interviews to get rich and detailed data (Guest, Bunce and Johnson, 2006; Baker and Edwards, 2012; Creswell, 2012). While not a recommendation of a sufficient sample size using a quantitative approach, it is evidence that saturation in qualitative research can be reached within this range of samples. Considering the

arguments on saturation of data related to the number of participants, a number of twenty-two participants to be interviewed is accepted as appropriate.

5.5 Recruitment and identification of the participants

The researcher used the organisations central e-mail distribution to ask for volunteers to support his research project as participants in semi-structured interviews. The sample criteria as presented in Table 13 to participate were highlighted in that e-mail. A study information pack was sent out to all volunteers. This information pack contained the project one-pager, the consent form, and the participant information sheet.

A total of 732 AT positions are in the PDD. The gender split for AT positions in the PDD is 9% women and 91% men. Forty-nine men and fourteen women all in AT positions agreed to participate in this research. The employee's information, containing the name, the gender and the salary group of the employee, was linked to a unique ID (participant number). This ID followed a coding scheme which allowed the researcher to recognize the gender of the employee only by seeing the ID. The coding schema works as follows: The acronym of the salary group (AT) was used followed by the gender which was coded with "M" for man and "W" for woman and linked with a unique number (1 to 50). For example, the coding "ATW4" describes participant number four who is female and allocated to salary group AT.

As stated from Marshall (1996) that random sampling is the most commonly used approach and the chance of selection for every sample is equal, random sampling is the valid approach to guarantee objectivity in research step two. The process of random sampling followed a similar logic to the approach used in research step one. The researcher used the random number function from MS Excel to identify the samples for examination. The researcher listed the IDs of the participants separated by gender in MS Excel and linked each participant ID with a random number generated by MS Excel. The IDs of the participants linked to the random number created by MS Excel were sorted according to the MS Excel random number from small to large. Out of the total range of respondents, twenty-two participants were randomly identified. The gender mix was thirteen men and nine women. In each gender category, the participant IDs linked to the smallest random numbers were identified as participants for the semi-structured interviews. After this random identification of the participants, each participant was invited to a face-to-face interview. In this invitation exclusively sent out to each of the twenty-two participants, each one was asked again to make themselves familiar with the study information pack. The familiarity of the participant with the study information pack helped the participants to achieve a general understanding of the project and to reduce the time needed to brief the participant upfront of the interview. As described above, the participants are all employees of the company the research took place in. No participant was handicapped or

somehow cognitively limited. Table 14 below summarizes the characteristics of the participants who took place in this research.

Table 14: Overview of interviewed participants

No.	Participant Number	Position	Age	Sex
1	ATM12	Vehicle Engineer	49	Male
2	ATM17	Attribute Engineer	54	Male
3	ATM19	Build Coordinator	31	Male
4	ATM21	Earned Value Analyst	34	Male
5	ATM23	Strategy and Planning Engineer	52	Male
6	ATM28	Sign Off Engineer	54	Male
7	ATM3	Build Coordinator	37	Male
8	ATM30	Development Engineer	46	Male
9	ATM33	Test and Development Planer	48	Male
10	ATM37	Budget Analyst	48	Male
11	ATM41	Attribute Engineer	35	Male
12	ATM7	Test and Development Planner	58	Male
13	ATM8	Product Planer	52	Male
14	ATW10	CAE Engineer	47	Female
15	ATW11	Resource Planer	56	Female
16	ATW13	Design and Release Engineer	42	Female
17	ATW14	Program Planer	42	Female
18	ATW2	Program Analyst	36	Female
19	ATW3	Planning Analyst	41	Female
20	ATW5	Quality Engineer	35	Female
21	ATW7	PMT Engineer	34	Female
22	ATW9	Core Engineer	35	Female

5.6 Administration of the interviews

According to Ritchie and Lewis (2012), Gray (2009) and Saunders, Lewis and Thornhill (2016) the participant has to be introduced to the topic and needs to be brought into an academic mood to deliver answers with rich information in such an interview. For each interview the researcher interrupted his work routine and brought participants out of their routines to participate in the interview. The situation was challenging on both sided with respect to getting into the academic mood and into the different interview roles (researcher to become interviewer as well participant to become interviewee).

According to Gray (2009), Ritchie and Lewis (2012) Saunders, Lewis and Thornhill (2016) it is important to take care of the interviewee in order to achieve results in conducting face-to-face interviews. This means picking up the participant for the topic, bringing the participant into an

academic working mood and, after completion of the interview, easing out of the mood of the academic exercise and bringing the participant back into the normal business mood. Hence each interview session was scheduled in two-hour blocks. As mentioned above, all participants received a study information package concerning the research project. Each participant was required to sign a consent form acknowledging a clear explanation of the project and his/her willingness to participate, thus, informed consent. Before signing the form of consent and handing it back to the researcher, the participant was given time prior to the interview to raise any questions related to the project. Therefore, a half an hour at the beginning of the interview is used to prepare the meeting, to brief the participant and answer the participant questions. One hour is used for the interview itself and a half an hour is taken to release the participant and for writing down thoughts on the interview. The interview started with an introduction of the project to the participant. This helped to pick up the participant for the topic and bring the participant into an academic working mood. After this introduction, the participant was briefed how the interview will be conducted. The researcher also explained the purpose of the fields of activity table (See Appendix 8) and how to use the table. Finally, the participant was asked if the project, the purpose of the project and the regulations behind this data gathering exercise were understood and are clear to the participant. After the conduction of the interview to ease out from the academic mood with the participants, the researcher asked for feedback from the participants with respect to the run of the interview and gave each participant feedback with respect to the interview. With this the participants had the opportunity to raise any open questions and to come back into the mood of the daily business.

5.7 Data analysis of research step two

The following sections are about the justification to use thematic analysis in research step two in this context. The method itself will be introduced to the reader by describing the six phases that were conducted during this thematic analysis and the point of data saturation in the process of coding is outlined. Furthermore, the achievements of each phase in this thematic analysis are highlighted to guarantee traceability of the development of the themes that were identified in the data. Finally, the findings of research step two are summarized and used to answer (RQ3) and (RQ4).

5.8 Using thematic analysis in research step two

Thematic analysis is a form of analysis frequently used in qualitative research and is classified as a foundational method in qualitative research (Braun and Clarke, 2006; Guest, MacQueen and Namey, 2011). While methods like discourse analysis, grounded theory, or narrative analysis are tied to theoretical frameworks in which the methods are frequently used, the use of thematic analysis is essentially independent from any theoretical framework (Braun and

Clarke, 2006, p. 78). This independence leads to a theoretical freedom which makes thematic analysis to a flexible method in qualitative research that can be applied to a variety of different approaches (Braun and Clarke, 2006).

The mixed method approach in this research combines a quantitative method with a qualitative method. Data that emerged from the use of a quantitative approach in research step one is used as foundation for the qualitative approach in research step two. Hence, research step one and research step two are interdependent. This interdependence contains, by a combined use of the results from the data analysis of both research steps in this thesis, the risk of an ideological conflict between the natures of the different approaches used in research step one and step two. Plante, Kiernan and Betts (1994, p. 53) claim that good or bad research is not based on a quantitative or qualitative approach, but that it is more related to an appropriate approach to investigate the problem. Plante, Kiernan and Betts (1994) refer with this statement to the long-standing debate about the appropriateness of qualitative and quantitative approaches, in essence, this statement moves away the focus from the quantitative versus a qualitative debate and puts it on the aim of the research. The use of thematic analysis with its independence from any theoretical framework helped this research to avoid the potential pitfall of the mentioned ideological conflict. Boyatzis (1998, p. 7) defined thematic analysis as “the bridge between the language of qualitative research and the language of quantitative research”. A position that Boyatzis (1998) shares with Crabtree and Miller (1992) and Denzin and Lincoln (2005). Crabtree and Miller (1992) and Denzin and Lincoln (2005) emphasized as well the interlinking attribute of thematic analysis that connects researchers out of different fields. This interlinking attribute can be traced back to the flexibility of the method or rather on the possibility of using this method independent from any theoretical stance (Braun and Clarke, 2006). Boyatzis (1998), Crabtree and Miller (1992) and Denzin and Lincoln (2005) describe by highlighting the interlinking attribute of thematic analysis, a supportive character of thematic analysis that can be used to smooth the intersection between the different research approaches of this research. Based on these arguments it was appropriate to use thematic analysis in research step two to harmonise the combination of the two approaches and to avoid ideological conflicts driven by the quantitative versus qualitative debate.

Beside the harmonisation of the two different approaches, the theoretical independence of thematic analysis in this research helps to open up the results for a wider audience. The use of thematic analysis, which builds the bridge between qualitative and quantitative research, opens up the findings of this research to researchers out of these different domains (Boyatzis, 1998). Boyatzis (1998, p. 7) describes thematic analysis as a translator between the quantitative and the qualitative language which, by providing access to discoveries, expands the audience for communication and dissemination. According to Boyatzis (1998), researchers

out of different domains are rapidly familiar with results that are based on the use of thematic analysis, an attribute of thematic analysis that supports an exchange of the results between the different domains. This improved exchange may lead to vibrant discussions on the results of this thesis across different domains and potentially generates further progress in research on tacit knowledge which is highly appreciated by the author of this thesis.

Braun and Clarke (2012, p. 57) claim that thematic analysis is a method of data analysis that is used to systematically identify and organize patterns of meanings in data. Patterns of meanings are called “themes”. Rubin and Rubin (2011) state that thematic analysis is a good method to identify concepts and themes from interviews. The identification of commonalities in collective and shared meanings within the data and to make sense of them lead to the creation of themes and enables the researcher to analyse the data corpus (Braun and Clarke, 2012). The term “data corpus” describes all the data collected for this special research step (Javadi and Zarea, 2016). Based on the fact that the primary focus in research step two is on the data corpus that is generated from the execution of semi-structured interviews and underpinned by the statements from Braun and Clarke (2006) and Rubin and Rubin (2011), that thematic analysis is used to elicit the themes in the data and helps to interpret the data according to their meanings, it can be stated that thematic analysis is an appropriate approach for data analysis in research step two.

Conducting thematic analysis can follow a deductive or an inductive approach. A deductive approach or top-down approach is applied if the researcher analyses or classifies the data based on existing frameworks, ideas, concepts or theories (Gray, 2009; Braun and Clarke, 2012; Saunders, Lewis and Thornhill, 2016). The thematic analysis carried out in this thesis applies an inductive approach. An inductive approach allows the researcher to analyse the data from emerging patterns. Braun and Clarke (2012) call this type of approach a bottom-up approach. Since the context in which this research is conducted has not been used for research on tacit knowledge before, a top-down frame that could be used in this context does not exist. The lack of existing theories, concepts, or ideas in this context made it necessary to navigate the research by the patterns that emerged from the data. Therefore, the absence of a theoretical framework in this context made it appropriate to apply an inductive approach in thematic analysis to deeper explore tacit knowledge in the form of skills, experience and abilities in research step two.

5.9 A six-phase process of conducting thematic analysis

Thematic analysis consists of different phases. Braun and Clarke (2006) describe six phases to conduct thematic analysis, starting in phase one with transcribing the data to become familiar with it. Transcribing the data describes the process of converting the verbalized data from the interview into a written form (Riessman, 1993). A step which is essential to apply

thematic analysis on the data. The process of transcription is a very intensive process of working with the data. Riessman (1993) recommends that the researcher who carries out the research should do the transcription himself / herself. Listening to the recorded interviews and writing the interview content down, reading and rereading and adjusting the written content allows the researcher to dive deep into the data and to become familiar with it. This familiarity helps the researcher get a first feeling for emerging patterns based on recurring content in the data.

The second phase describes the generation of initial codes. In this phase the researcher initially systematically codes interesting features of the data. Codes are descriptive summaries of small data sections (DeSantis and Ugarriza, 2000).

In the third phase the initial codes are collated into potential themes. This means sorting the different codes and combine those codes into common themes.

The fourth phase is to review the different themes, to check if the themes are clearly distinctive to each other and if the themes can be fed from the content of the gathered data. The themes should contain information relevant for answering the research questions (Braun and Clarke, 2006, p. 82). Finally, this level must result in an idea of the overall story the data can tell.

The fifth phase is an ongoing process of refining the naming of the themes by generating clear definitions of each theme and adjusting the naming of the theme accordingly, if necessary. A level that helps to narrow the data to the real essence of the data.

Phase six is the final phase used to produce a scientific report. Braun and Clarke (2006, p. 87) call this phase the last level of analysis. The purpose of this phase is to select vivid and compelling extracts and relate this back to the research questions and the literature. Hence the last level of analysis tells the story of the data by answering the research questions.

The six-phase structure in thematic analysis as described by Braun and Clarke (2012) is used by the researcher in this thesis to systematically analyse the gathered data in order to answer RQ3 and RQ4.

The next subsections explain the procedures undertaken for each phase of this thematic analysis. The outputs generated in each phase are summarized to guarantee traceability of the results in this thesis and to guide the reader of this thesis through the process of conducting thematic analysis in this context.

5.9.1 Thematic analysis phase one: Familiarization with the data

The aim of phase one in thematic analysis is to become familiar with the data. For the researcher the process of becoming familiar with the data already started before the start of thematic analysis. Familiarization with the data took place at an early stage in research step

two. Research step two was the conducting of interviews that were audio recorded. The researcher decided to conduct the interviews by himself. This helped the researcher develop first analytical thoughts and prior knowledge on the gathered data at an early stage in the process of this thematic analysis (Braun and Clarke, 2006). Upcoming patterns in the answers of the interview questions given by the interviewees were detected by the researcher and written down in field notes. To analyse the data which were gathered during the interview, it was necessary to convert the audio recorded data into a written form by transcribing the data.

Transcribing the data was also carried out by the researcher himself. Riessman (1993) understands the process of transcribing the data as a perfect start of familiarization with the data. Field notes that were taken during the interviews were used in the process of transcribing the data to focus on specific sections in the interviews, sections that potentially contain essential data to answer the research questions in this study. The combined review of field notes and listening and re-listening to the audio records of these specific sections by transcribing the data helped the researcher to become familiar with the data.

Transcribing audio recorded data can be carried out in different ways. Verbatim transcription covers all spoken sounds including filling words, laugher, and throat cleaning sounds. The transcribed words are an exact replication of the recorded words (Poland, 1995). Poland (1995) claims that an exact replication is problematic because communication is in human nature an interpretative activity, a circumstance which often lead to a high number of significant transcriber errors (Poland, 1995). Bucholtz (2000) highlights that adding every spoken word into the transcriptions makes the transcription hard to read, a circumstance that makes working with the transcription challenging.

Another type of transcribing audio recorded data is edited transcription. Edited transcription contains analysis and interpretation of the data by transcribing only the relevant material and removing stutters, interjections and filling words for the purpose of specific analysis (Mondada, 2007). Hence, edited transcription is not like the clerical task of verbatim transcription, it is more an exercise of interpretative and analytical thinking with the focus on the content of the data (Lapadat and Lindsay, 1999). Halcomb and Davidson (2006, p. 40) clearly question the need for verbatim transcription and state that the use of thematic analysis, which seeks to identify common themes in the data, does not require verbatim transcriptions. A position that can be underpinned by Silverman (2014) who indicates that verbatim transcription does not add additional value in every research project. Braun and Clarke (2006) emphasize that it is important that the transcript retains the information which is relevant for the research. Edwards and Lampert (2014) claim that the concept of transcription must fit to the aim of analysis.

The focus of this thematic analysis is on the semantic content of the interview which can be interpreted without writing down all filling words (e.g. “ah”, “hm”, or “umh” etc.), throat cleaning

sounds or laugher a verbatim transcription would include. Based on the findings in the reviewed literature in the field of verbatim transcriptions and the focus of this thematic analysis, a use of verbatim transcription in this research is not constructive. To identify common themes in the data by the use of thematic analysis it was appropriate to carry out an edited transcription in this research.

Summarised, it can be stated that phase one of thematic analysis, familiarization with the data, started with conducting the interviews and transcription of the data. Both actions carried out by the researcher himself helped the researcher to become rapidly familiar with the data. The output of this phase was the transcribed interview data and first ideas about specific content of the data that built patterns and could be interesting for further analysis. The depth of analysis in thematic analysis is increased from phase to phase which means that each phase is linked to another. There is no clear demarcation in the process of thematic analysis between each of the phases. It is more an ongoing process of structuring and analysing the data. After transcribing the interview data, the researcher created a summary of his initial thoughts on the interview content of every interview. In essence it was recognized by the researcher that the use of tacit knowledge in the form of social skills was emphasized in the majority of the interviews, an impression which already occurred while conducting of the interviews and was confirmed by transcribing the data. These initial thoughts were part of the process of becoming familiar with the data and helped the researcher to create an overall mental picture with respect to the relevance of specific information given during the interview.

5.9.2 Thematic analysis phase two: Generating initial codes

Phase two of thematic analysis is about the generation of initial codes within the interview data. Codes highlight semantic or latent content within the data. “Codes refer to the most basic segment or element of the raw data or information that can be assessed in a meaningful way regarding the phenomenon” (Boyatzis, 1998, p. 63). The codes in this thematic analysis are data driven and built around the research questions of this thesis. To identify these initial codes the researcher combined continuously reading and rereading the transcribed data with listening to the audio recorded interviews. For each interview a consolidated extract of the identified codes applied to the related data of each interview was generated. These extracts helped to systematically summarize relevant features of the data to meaningful groups as part of further analysis to deeper explore the phenomenon tacit knowledge in this context (Miles, Huberman and Saldana, 1994; Tuckett, 2005a). Repeated patterns of data around the research questions in this study, which occur across the whole data set, were identified. These patterns were coded to build the basis of specific themes which are developed in phase three of this thematic analysis. The table 15 below shows an extract of initial codes related to the

most frequently occurring patterns and the segments of the interview data from the participants the codes were applied to.

Table 15: Overview of initial codes

Code	Data extract
• The importance of social skills	*It's mandatory to have social skills, because without socializing you will not be recognized by other people. People will not get in touch with you later on because they would think "why should I get in touch with this guy if I don't have any benefit from it?* ***(ATM12)*** *...if you don't have good social skills, you won't get the team working together or won't get the help from the team. You will maybe not get the information which are required to make your job right* ***(ATM19).*** *…if you're not a social person you'll not be able to have any good results in this company. Alone in your office you will not be able to develop any solutions for problems or new items or technical stuff* ***(ATW5)***
• The use of social skills • Making things work • Bringing people together • Align people • Convince people	*We, within the build management team are, as I like to say the "engineering's nanny". We are combining and getting people from different departments together. -Drive a team to a predefined target that you're always clear on you vision where to go, what does it mean to go there and who do I need for that.* ***(ATM3)*** *You know which items are essential to get the program progressed and what kind of issues would have an impact on the further timing of the program, or costs or feasibility from design point of view.* ***(ATW2)*** *That's really a nursery job to evaluate upfront who is the critical person within the team and who is usually not following my guidance to deliver the result in a timely manner - For other people simply writing them an email is enough and it works, but for some you have to do a daily follow up and guide them through the whole issue process* ***(ATM23)*** *It's engineers, the finance group or purchasing and our main focus for planners is a kind of project management and bringing all the parties together to develop a good and nice product to earn money with.* ***(ATW3)*** *I couldn't have done that without the skills like talking to people, bringing people together and explaining what we're doing. And bringing all these things together to get it work. - Working with different departments, not just following a procedure but bringing people together and getting things done.* ***(ATM17)*** *…trying to get people on your side and convince them to do things although their process tells they probably shouldn't be doing.* ***(ATW14)*** *…In the end helping them to get their work successfully done.* ***(ATM30)***

Code	Data extract
• Lessons learned	*… if you know which tools you use, how something worked in a previous project, then you get the job done much faster* ***(ATW7)*** *Experience is very important because if you get more and more information from different situations, different programs or different people you can re-use them next time. This helps to get a solution* ***(ATM33)***
• Network	*It's very important to have something like a network - Really important is the last skill I mentioned, the social aspect and the Network* ***(ATM30)*** *…with my network and when you're asking someone from another department, then they're totally open and not critically rejecting you* ***(ATM41)***
• Not necessary to be a technical expert	*You come into my job with just the theoretical background, since it's not required to come here as a technical engineer.* ***(ATM8)*** *But for my function I don't need the real in-depth knowledge of every single subject Because I have the engineers who are responsible for these specific components and I can speak to them.* ***(ATW7)*** *Technical skills are needed in some way, but I think for me it's not the most important…* ***(ATW13)***
• Broad experience • Overall view • Feeling	*We have different experiences and experience gives you the confidence that you can resolve it and that you can do it. It's a big backpack of tools, knowledge… I think it's the experience with all departments supporting a total vehicle.* ***(ATM28)*** *beneficial in this job if you have worked in other departments of the company before…. You need to have a high-level picture, how does the project work in the entire business environment.* ***(ATM21)*** *They all have different interests in the topic I am working on so you need to get a feeling for what every party need and expects so you need some experience for a lot of project which you get over time of course.* ***(ATM37)***
• To teach colleagues	*I exactly need to know how it works and also be able to explain this to others… I'm there to teach them…****(ATW9)*** *…you have to explain very much in detail and pick them up from a lower knowledge base* ***(ATW5)*** *…I worked as kind of a coach for the new team members* ***(ATM17)*** *We're always getting new team members and it's one of my jobs to teach them.* ***(ATW11)***
• Prepare data for management	*…put it into a language that the management can understand in a short space of time. I would say it's like trying to write to an intelligent 10-year-old. So they can read it and know exactly what I'm saying* ***(ATM8)*** *…create the format ourselves to communicate also to our own management when we need to make it understandable and to have it more high-level* ***(ATW7)***

In summary, in phase two of this thematic analysis all the data patterns which frequently emerge across the whole data set were initially coded. The coding explicitly showed that codes that occur with a high frequency across the whole data set are strongly related to social skills. At this stage, the researcher was able to generate a deeper insight into the use of social skills in this context. It was recognized that the use of social skills is related to making things work, to bringing people together, to teaching people, to creating network, to communicating or sharing information with others. Thus, the use of tacit knowledge in the form of social skills can be linked back to multiple processes and actions in this context. To achieve progress, the possession and the use of social skills seem (from the participants) to be perceived as more important than to be a technical expert or to possess great technical knowledge, a finding that indicates the high importance of social skills versus the importance of technical knowledge in an engineering driven organisation. Another tendency with respect to the use of the predominant forms of tacit knowledge is related to experience. Broad experience and lessons learned were linked from the participants with successful and efficient performance in this context. The output of this phase was beyond a full coding of the interview data, an initial notion of a potential story the data could tell. The use of tacit knowledge in the form of social skills and experience seem to build central topics in this organisation which are worth further exploration in the next steps of analysis.

5.9.3 Data saturation

Based on the analysis that was carried out to generate the initial codes in phase two of this thematic analysis, the researcher recognized that after the analysis of twelve interviews the number of new codes generated by this analysis dropped dramatically. After the analysis of sixteen out of twenty-two conducted interviews, no new information was generated. At this point, the data collection had reached saturation and the generation of new codes that would form further essential patterns in the data was not possible (Guest, Bunce and Johnson, 2006; Walker, 2012). Despite that saturation of data occurred after the analysis of sixteen interviews, the researcher coded all twenty-two interviews which helped to reconfirm already identified codes. The analysis of the last six interviews, in which no new codes were generated, underpinned the occurrence of data saturation in the sixteenth interview. A circumstance that implicates that enough data is collected to have a representative range of experience within the data that allows to replicate the study (Mason, 2010; O'Reilly and Parker, 2013).

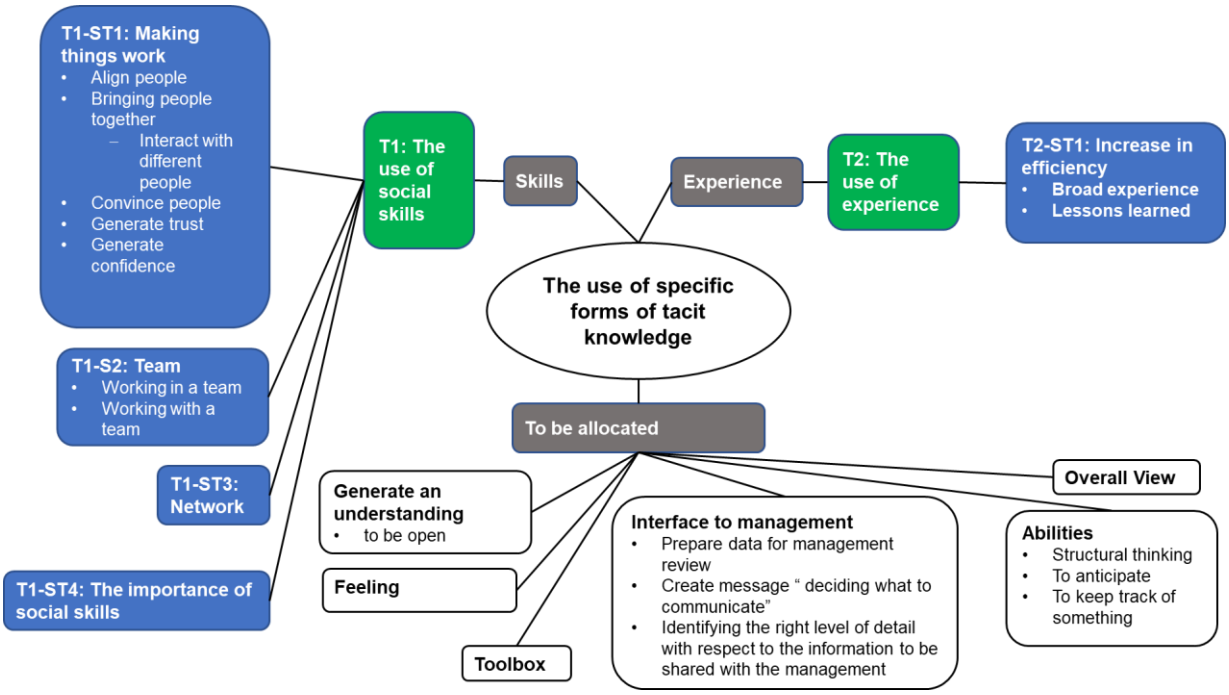
5.9.4 Thematic analysis phase three: Searching for themes

Braun and Clarke (2006) state that phase three in thematic analysis is about refocusing the analysis at a broader level, stepping back from the coding view to a theme view. Boyatzis (1998) categorized this process as interpretative. The researcher in this thesis generated a mind map to sort single codes with similar characteristics into groups. Collating all the codes

under summarizing headers helped to combine different codes to create a collection of possible all-embracing themes. Brink and Wood (1998) state that bundling data around a main issue in thematic analysis is described by the use of the term “theme”. Streubert and Carpenter (2011) define “theme” as a structurally meaningful unit of data that is used to underpin findings in qualitative analysis. A theme is the result of a meaningful organisation of coded data (Javadi and Zarea, 2016). Themes can be identified on the semantic (explicit) level of data or on the latent (interpretative) level of data (Braun and Clarke, 2006; Javadi and Zarea, 2016). The focus of a semantic approach in detecting themes lies only in the statement from the participant, while the focus of a latent approach lies beyond this. A semantic approach emphasizes the importance of patterns in the data and their wider interpreted meanings, and the latent approach is about testing of beliefs and presumptions by interpreting the conceptual background of the semantic structuring of the data (Boyatzis, 1998; Braun and Clarke, 2006; Streubert and Carpenter, 2011).

This thematic analysis concentrates on tacit knowledge frequently used in this context, identified in research step one. The forms of tacit knowledge occurrence are based on the theoretical concept of ETK developed by Haldin-Herrgard (2003). Thus the forms of tacit knowledge occurrence are transparent to the researcher and limited to the approach from Haldin-Herrgard (2003). Since research step two was designed on the results of research step one and concentrates on how and for what purpose is tacit knowledge in the form of ETK frequently used in the PDD, the form of tacit knowledge occurrence is clearly defined. Hence, the testing of beliefs and presumptions, a latent approach would go for to detect themes, is in this context not constructive. The existing and accepted knowledge base behind the use of ETK does not make it necessary to unearth and analyse latent content in the data to verify or launch new beliefs. The detection of themes on the semantic level to emphasize the importance of data patterns and their interpreted wider meanings is an appropriate approach in this analysis to further explore the usage of tacit knowledge frequently used in the PDD and to answer the research questions in this study. The mind map below demonstrates the identified initial semantic themes (Tx) and sub-themes (Tx – STx) for this thematic analysis:

Figure 13: Mind map of initially-identified themes and sub-themes



The mind map is organised around the central topic of the research questions RQ3 and RQ4 in this thesis, the use of the specific forms of tacit knowledge. Themes to be developed by creating this mind map need to contain information that are relevant for answering the research questions in this thesis (Braun and Clarke, 2006, p. 82). This mind map shows the relationship between the codes and how the codes are building themes and sub-themes. As it was already indicated by the interpretation of the interview data in phase two of this thematic analysis, the mind map outlines that most of the codes are linked back to the use of social skills. Skills as form of tacit knowledge frequently used in this context occur across the whole data set in the form of social skills. Using tacit knowledge in the form of social skills builds an essential element in different activities and processes in this context. Hence, the interview data around the use of tacit knowledge in the form of social skills builds one potential candidate for a theme (T1 Green). Related sub-themes (T1-ST1 to T1-ST4 Blue) for the use social skills were created and indicate the interlacement and the importance of the use of social skills in this organisation. A further candidate for a main theme (T2 Green) is the use of experience in this context. As the sub-theme (T2-ST1 Blue) indicates is the use of experience linked to an increase in efficiency in the daily business. Broad experience and lessons learned take place in this field. To further ascertain the use of tacit knowledge in the form of experience, interview data around the use of experience in this organisation have to be analysed. These findings made it appropriate to identify the use of experience as a second potential main theme (T2) in this analysis. According to Braun and Clarke (2006) some codes cannot be directly linked to identified initial themes. Braun and Clarke (2006) strongly emphasize to collecting these themes under a central header and not to abandon anything at this stage. Codes that seem

not to belong to any of the themes or sub-themes at this stage in the analysis were summarised under the header “To be allocated” and remained part of this analysis. The flexibility of thematic analysis allows reallocation of these codes to a identified themes in a later stage of this thematic analysis (Braun and Clarke, 2006).

5.9.5 Thematic analysis phase four: Reviewing potential themes

Phase four describes the review of potential themes identified in phase three. The purpose is to check if the themes can be served by the gathered data that and if the identified themes clearly distinct to each other (Braun and Clarke, 2006). DeSantis and Ugarriza (2000) formulated four criteria to define the concept of a theme. Criterion one is the emergence from data. Themes emerge from the data gathered and do not need any supporting evidence for their existence from other sources (DeSantis and Ugarriza, 2000, p. 363). The second criterion is that a theme is abstract in nature. In the majority of cases themes do not occur explicitly expressed in the data. Themes are embedded in the data and need to be elicited from the data (Morse and Field, 1995). The third criterion is iteration. Iteration means in this context the recurrence of experience in the form of patterns with respect to behaviour, ways of thinking, acting or feeling (DeSantis and Ugarriza, 2000, p. 363). According to DeSantis and Ugarriza (2000, p. 363) iteration makes themes identifiable and possible to transform the implicit meaning of the theme to the explicit meaning by the researcher. The last criterion is the level of theme identification. DeSantis and Ugarriza (2000, p. 363) claim that themes occur in categories, domains and taxonomies. Emerging patterns of meanings or experiences within these three different levels, where the concept of a category is the lowest level and a taxonomy the highest level, can be classified as themes.

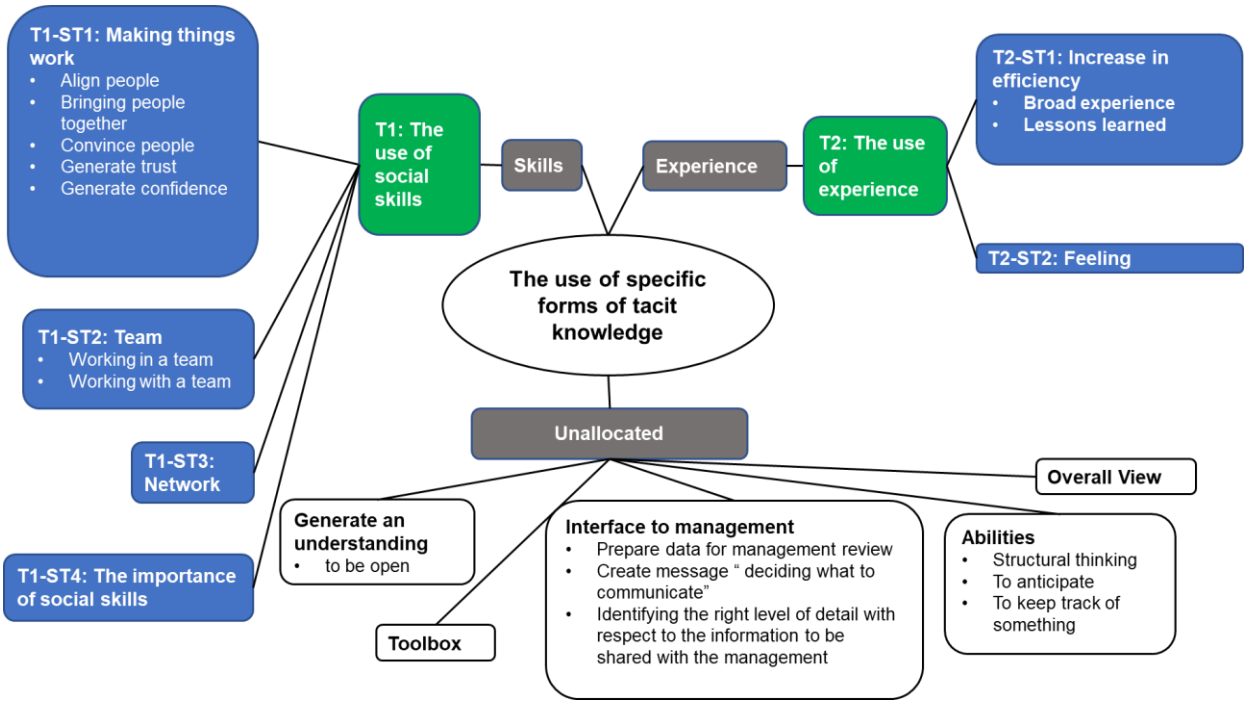
The researcher used the four criteria to re-assess if the initially identified main themes in the prior phase contain the characteristics of these four criteria. It can be stated that both themes, “The use of social skills” and “The use of experience” emerged from data, can be fed from the data, are abstract in nature, and were iterated across the whole data set. Categorising the use of tacit knowledge by using the categories skills and experience it can also be stated that the themes emerged within these categories. In conclusion the themes “The use of social skills” and “The use of experience” are, according to the criteria from DeSantis and Ugarriza (2000), appropriate themes. The sub-themes T1-ST1 to T1-ST4 related to the theme “The use of social skills” as well the sub-theme T2-ST1 related to the theme “The use of experience” also fulfil the four criteria of a theme defined by (DeSantis and Ugarriza, 2000). Further results of phase four are, according to Javadi and Zarea (2016), the idea about the differentiation between the themes, how the themes match to each other, and what the overall story is the themes are telling. While theme one (T1) “The use of social skills” is related to the use of tacit knowledge in the form of social skills, theme two (T2) is related to the use of tacit knowledge in the form

of experience. Hence the two themes are differentiating from each other by the form of tacit knowledge used, whereas the matching criteria of these two themes is seen in the circumstance that both themes refer to the use of tacit knowledge. The overall story the data tells is how tacit knowledge in the form of social skills and experience are applied in this context to achieve what purpose, an overall story that contains all the information relevant for answering the research questions in this thesis, which is according to Braun and Clarke (2006, p. 82) a key result of phase four in thematic analysis.

5.9.6 Thematic analysis phase five: Defining and naming themes

The fifth phase is about eliciting the essence of each theme. The essence of a theme describes the message the theme is about and the aspect of the data that is embodied in the theme (Braun and Clarke, 2006). Clear definitions of each theme and each sub-theme by defining and refining the themes and sub-themes based on a further review of the gathered data was done. The exercise of defining and refining the themes and sub-themes led to a final determination of main themes and related sub-themes. According to Braun and Clarke (2006, p. 92) sub-themes are essentially themes-within-a-theme which are useful to structure the data within a theme by adding a hierarchy of meaning to the data. Since thematic analysis is an ongoing process of analysis, each conducted phase in this process leads to new findings and deeper insights on the phenomenon. Based on this constant progress, the researcher further developed his focus of investigation and his notion of the interdependencies within the data, a circumstance that enabled the researcher, at this stage, to identify further relations within the data and to reallocate a code identified in phase four, but not linked to a specific theme. The code was located under the header “To be allocated”. The code “Feeling” was reallocated as a new sub-theme (T2-ST2) to the theme (T2) “The use of experience”. The mind map below shows the result of the reallocation of the above-mentioned sub-themes. The header “To be allocated” was renamed into “Unallocated. The remaining codes under this header could not be linked to a specific theme or sub-theme with respect to the research questions in this thesis. Therefore, these codes are no longer part of the final analysis in phase six. Since these codes represent findings of phase three which might be interesting for future research with a different aim and for the purpose of transparency, these codes are not removed from the mind map, but instead these codes are still tracked under the header “Unallocated”.

Figure 14: Mind map of themes with the reallocated sub-theme.



In summary, this mind map shows two themes T1 “The use of social skills” and T2 “The use of experience”. T1 contains four sub-themes (T1-ST1 to T1-ST4), T2 contains two sub-themes (T2-ST1 to T2-ST2). Braun and Clarke (2006, p. 92) state that the researcher at this point has to be able to describe the content and the scope of the theme in a couple of sentences. Doing so, the researcher demonstrates that each theme is now clearly defined with respect to what the theme is about. According to this requirement the researcher created following descriptions of theme T1 “The use of social skills” and theme T2 “The use of experience”:

Theme T1 “The use of social skills”

This theme is about the use of tacit knowledge in the form of social skills in this organisation. Tacit knowledge in the form of social skills is used by knowledge workers in this organisation in a multitude of processes and situations. Social skills are classified by the majority of knowledge workers as the most important skills to have in this engineering-dominated organisation. This theme draws a picture of tacit knowledge in the form of social skills which is used as a pacemaker for development work by knowledge workers to enable performance and facilitate essential actions within the field of development work in this organisation.

Theme T2 “The use of experience”

T2 is about the interdependencies between the use of tacit knowledge by knowledge workers in the form of experience and the effect of this knowledge usage on the performance of the possessor and the organisation.

5.9.7 Thematic analysis phase six: Producing the report

The sixth phase is the last level of analysis (Braun and Clarke, 2006). The final analysis was written down in a scientific report. Before this final analysis was casted in the report, the themes and sub-themes were renamed, while in phase five there was still the use of working titles for the themes and sub-themes. Braun and Clarke (2006) emphasize that, after clearly defining the themes in phase five, a renaming in phase six of the themes has to take place. The name of each theme and sub-theme need to be punchy to directly generate an understanding for the reader of what the theme is about (Braun and Clarke, 2006). The working title of theme T1 and T2 and the related sub-themes were renamed as follows:

Theme T1:

- T1: The use of social skills was renamed in → T1: The use of tacit knowledge in the form of social skills to facilitate development work

The related sub-themes of T1 were renamed in:

- Making things work was renamed in → The importance of tacit knowledge in the form of social skills in making things work
- Team was renamed in → Social skills as a key for working together and building teams
- Network was renamed in → The use of social skills to establish networking
- The importance of social skills was renamed in → Social skills recognized as required resource in the PDD

Theme T2:

- T2: The use of experience was renamed in → T2: The use of tacit knowledge in the form of experience to enhance development work

The related sub-themes of T2 were renamed in:

- Increase in efficiency was renamed in → Personal experience as a pacemaker for efficiency increase
- Feeling was renamed in → Processing personal experience to develop self-confidence or a sense for upcoming issues

The next sections demonstrate the prevalence of the themes by highlighting data extracts from the interviews. Moreover, are the findings of research step two, that were made by the analysis of the data gathered during the interview, are summarized and used to answer RQ3 and RQ4.

5.10 Report: The findings of research step two

In the scope of twenty-two interviews, the participants described the use of skills and experience in their positions. They shared their personal definition of skills and experience in their context and identified the kind of skills and experience frequently required in their positions. The participants judged the skills and experience they use in their positions according to the effect on their performance. They gave their views on the importance of skills and experience to the end results of their work and made related examples out of their daily business. These findings outline the use of tacit knowledge by the interview participants of the case organisation. Patterns identified in the interview data have formed two themes, each with different sub-themes. The majority of the participants in this engineering-dominated organisation perceived the possession of technical skills or technical expertise in their position as less important than the possession and use of social skills. It seems that the use of tacit knowledge in the form of social skills builds a central theme in this organisation. The overall position of the participants can be summarized by the following quotation:

ATW11: "I think without social skills you don't get an end result".

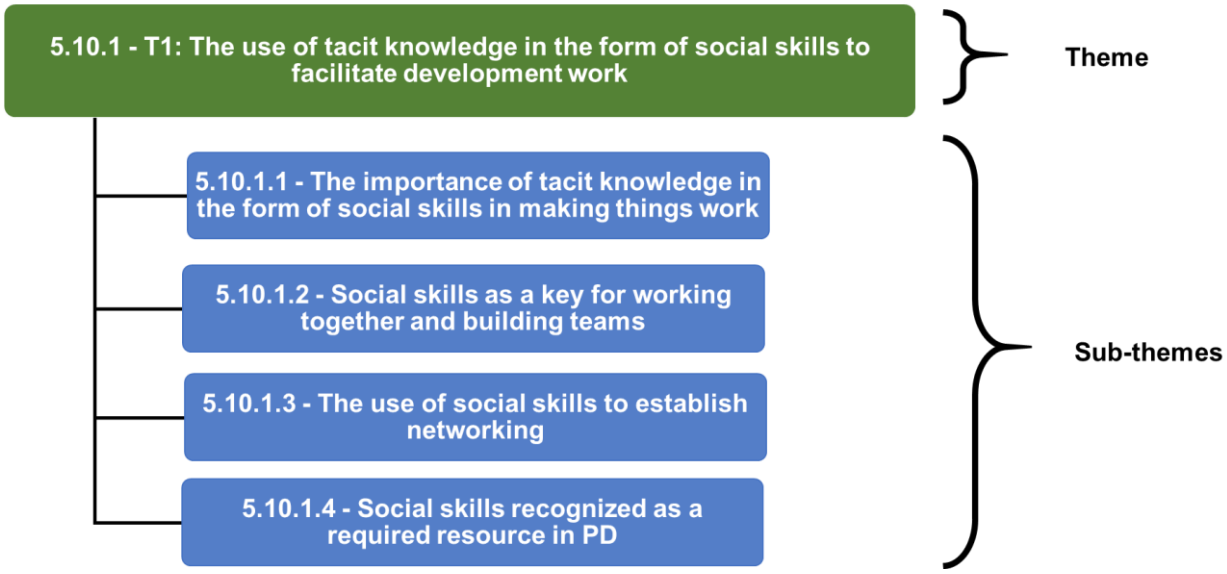
Out of these findings theme T1 - "The use of tacit knowledge in the form of social skills to facilitate development work" - was developed. In addition to these findings, the interview data has shown that the use of tacit knowledge in the form of experience is linked to an enhancement of development work carried out in this organisation. Tacit knowledge in the form of experience used by the participants seems to build the foundation for processing personal experience. The patterns in the data related to the use of tacit knowledge in the form of experience were used to develop theme T2 - "The use of tacit knowledge in the form of experience to enhance development work".

The following sections seek to illustrate the two themes and their related sub-themes that have emerged from the analysis of the data, gathered during the conducting of the interviews to deliver deeper insights on the use of specific tacit knowledge frequently applied in this organisation.

5.10.1 Theme (T1): The use of tacit knowledge in the form of social skills to facilitate development work

Figure 15 below shows an overview of the theme T1 - “The use of tacit knowledge in the form of social skills to facilitate development work” and the related sub-themes that are presented in this section.

Figure 15: Theme T1 and related sub-themes



Starting with theme T1 - “The use of tacit knowledge in the form of social skills to facilitate development work”

This theme shows the effect of the use of tacit knowledge in the form of social skills on the development work in this organisation. Frequently-occurring patterns in the data show that the use of tacit knowledge in the form of social skills by participants of this organisation builds a central topic in this organisation to facilitate development work. A multitude of activities as part of the development work carried out in this organisation are strongly related to the use of tacit knowledge in the form of social skills. Tacit knowledge in the form of socials skills triggers and supports development work. Working together, building up teams, or developing and using networks can be traced back to the use of tacit knowledge in the form of social skills, a circumstance that is well recognized by the knowledge workers in this organisation. The sum of activities with respect to the use of tacit knowledge in the form of social skills in the identified four sub-themes below builds the content of this theme and generates the complete picture of the use of tacit knowledge in the form of social skills to facilitate development work. Under the header of the related main theme, all four sub-themes below are with regards to the content interwoven to each other. The following subsections outline the four sub-themes that emerged from the data:

- The importance of tacit knowledge in the form of social skills in making things work.
- Social skills as a key for working together and building teams.
- The use of social skills to establish networking.
- Social skills recognized as a mandatory resource in the PDD.

5.10.1.1 The importance of tacit knowledge in the form of social skills in making things work

The majority (n=20) of the participants described their roles in the organisation as someone who make things work. Making things work is in this context related to activities that are frequently carried out by the participants. Activities the participants referred to were interacting with people, creating trust, convincing people, bringing people together, and aligning people. These verbalised activities are located in the field of social activities and stand for the use of tacit knowledge in the form of social skills:

The participants compared their roles in the organisation to the role of a daddy, friend or a nanny:

> *ATM28: "When you interact with the people, you're very strong confronted with the social part of my work. You need to talk to the people as a friend or as a daddy, a good daddy of course and not a top-down daddy. Someone who wants to help like a friend or colleague".*
>
> *ATM3: "We, within the build management team are, as I like to say the "engineering's nanny".*

A daddy´s or nanny´s role describes more than verbal conversation. It describes taking care for children, to support, to give advice and to give direction during the course of growing up. A nanny or a daddy has to control her or his own emotions and has to be focused always on the overall goal behind activities.

Participants also have challenges to cope with in these contexts:

> *ATM3: "We are combining and getting people from different departments together. We're linking them to each other, so it's important that you know how to communicate and bring people together. Drive a team to a predefined target that you're always clear on your vision where to go, what does it mean to go there and who do I need for that. And how do I, without emotion, bring the team together to work and make them understand, that we have a common goal. So that's the key element in my work".*

The participant emphasized that it is important to know how to talk to people to bring them together, a telling statement that allows the conclusion that the participant is aware that only a specific form of talking to or interacting with people will end in the result that people can be

brought together. The right way to talk to people, to get in contact with people and to bring people together were verbalised by the majority of the participants and can be seen as activities that refer to the use of tacit knowledge in the form of social skills. Back to the self-conception of the participants that they are daddies or engineering´s nannies, they feel responsible for making things work by bringing the team together and making them understand that they have a common goal. Doing all that without emotion, like ATM3 stated, stands for the use of tacit knowledge in the form of social skills. In this context, "without emotion" means to be able to work with every person in the team regardless of any personal differences or to be able to neutralize personal stress or absorb upcoming tension during the process of development and not give it back to the team. The reduction of other people's stress by working together with these people was highlighted as well by the majority of the participants. Tacit knowledge in the form of social skills helps to handle such situations by using the right approach of communication or behaviour in these situations. By stating "that is the key element" in his work, the participant ATM3 emphasized the importance of being able to handle these kinds of challenges which means that the use of tacit knowledge in the form of social skills is mandatory in his position to make things work and to achieve a common goal, a circumstance that emerged as a pattern across the whole data set.

Another participant described the use of tacit knowledge in the form of social skills for bringing people together and making people understand there is a common goal by stating:

> *ATM41: "You have to be a good listener and at the same time you have to absorb what other people say or do and you need to be able to sense all this stuff. Nobody in our group is working on a topic alone so it's important to keep the team together. That's what I mean with social. To maintain or ensure that everybody understands that there is a common goal".*

The participant refers to sensing, which is an abstract activity that is located in the field of using tacit knowledge in the form of social skills. By his ability to sense all this stuff he makes sure that he is able to keep the team together and to align the people on a common goal. The participant locates that activity in the social field of activities.

Other participants described the use of tacit knowledge in the form of social skills by referring to soft skills to achieve the goal of making people work and doing the right things.

> *ATW14: "I wouldn't say it's a specific skill from marketing plus a skill from chassis for example. It's the soft skill of assuming over basic knowledge. It's the soft skill of knowing how to get people to do what's needed really".*

A further participant explained the use of tacit knowledge in the form of social skills to make things work in the way the participant wants them to work:

ATW7: "It's very much people work like speaking to people, finding the right people and communication to them in a way that they want to do what I want them to do".

With this *ATW7* also emphasized the importance of the way of communicating with people to make things work and to achieve a goal which is given by the participant herself. Speaking and communication are building separate items in that statement. While speaking to people describes the way of verbalising things, communication describes multiple ways of interacting with people (e.g. body language). The participant describes with this the symbiosis of the spoken word and the performed meaning which also represents the use of tacit knowledge in the form of social skills to make things work.

Another participant linked the use of tacit knowledge in the form of social skills with the importance of personal contact for making someone performing in the way the participant wants him or her to perform and with this to make things work:

ATW3: "Of course, there are many different ways to bring people to do what you want them to do, but I believe, the personal contact is very important, writing a note, give a call or visiting their office".

This participant also presents some kind of personal "escalation routine" in the use of tacit knowledge in the form of social skills in her statement. The order in these "escalation steps" is given by the activities she conducts to get in contact with a person and make the person do what she wants the person to do, to make things work. While writing a note is mainly related to use of explicit knowledge (writing down structured signs, which become in the context data and finally information), the personal visit in the office stands for the use of tacit knowledge in the form of social skills. Communication by using tacit knowledge in the form of social skills can be carried out by the use of multiple channels and approaches, which increases the possibility of achieving the participants goal to make things work. The circumstance that the participant verbalised this kind of order shows that the participant experienced that this way of "escalating" increases the possibility of achieving the participants personal goal and with this to make things work. The majority of the participants recognize that the interaction with other people and to be able to bring them together requires special skills and that without these special skills they wouldn´t be able to make thinks work:

ATM17: "I couldn't have done that without the skills like talking to people, bringing people together and explaining what we're doing. And bringing all these things together to get it work. If I would simply follow a procedure like just write a work request, wait until they get back to me that I can finish my work, it would have taken ages".

The participant emphasized with this as well that only writing a work request, which stands for processing explicit knowledge, does not lead to a satisfying result in terms of making things

work. To avoid this unsatisfying result the participant uses his tacit knowledge in the form of social skills by talking to people, bringing them together, make them understand what is expected from them and finally to make things work.

Another participant describes the process of making things work by the use of tacit knowledge in the form of social skills by referring to a feeling the participant has:

> *ATM3: "The most important skill is to get a feeling for what your counterpart expects from you and what you should or should not tell him and how to get results from people".*

The circumstance that the participant verbalised that the most important skill is a feeling which is not more explicitly described from the participant demonstrates that the participants use tacit knowledge in the form of social skills to make things work. By defining a feeling as the most important skill, the participant overcomes the challenge to verbalise the use of tacit knowledge. The feeling the participant describes is related to the use of empathy to sense what the counterpart expects. With this, the participants use deeply ingrained tacit knowledge in the form of social skills to finally get results from people.

Another participant describes the use of empathy with:

> *ATM21: "You have to anticipate what the person on the other side is really expecting and put yourself in their shoes for a moment or be careful what kind of information do you leak before the meeting because this can create some appetite for something which is not there afterwards".*

To anticipate what a person expects by stepping into their shoes for a moment and meeting the expectations of the other person also describes the process of using tacit knowledge in the form of social skills. Meeting the expectations of the other person by managing the leaking of information based on the use of empathy enables the participant to stick to his plan of achieving a personal goal and to make things work.

The above-described patterns of using tacit knowledge in the form of social skills within a multitude of activities carried out in this organisation to make things work emerged across the whole data set. A further aspect which occurs within the data by the use of tacit knowledge in the form of social skills to make things work is the creation of trust. Trust helps to generate an environment in which development work can be carried out. The majority of the participants are consciously trying by using tacit knowledge in the form of social skills to create a trustful way of working together and with this this to make things work.

One participant explained that beyond bringing people together, the creation of trust helps to make the team share all the information with each other which makes things work. In this case that the communication goes fluently. The participant argued as well that, where there is a lack

of trust, information could be held back from the team because of the fear of consequences for the possessor by sharing this information. He recommends a “social network of trust” in the team to overcome these potential pitfalls:

> *ATM19: “They need to work together in a social way so that you’re building bridges between people and suppliers so that the communication is going fluently, and you also have a trust to each other to avoid the habit to not tell all information you have. It is more important to have a social network of trust in your team so that all information are shared and nobody keeps back information because of the fear, these information can be used against yourself somehow”.*

Furthermore, the participant classified trust as a social phenomenon and explained how he applied his tacit knowledge in the form of social skills:

> *ATM19: “Trust is always a social phenomenon because you only trust in a network or different people, if you socialize with them you build up trust. It’s also kind of located in the mental activity area because you need to get into other people’s minds so social and mental activities are connected to each other. But I think the most part is social because with social skills and social networks like having a coffee together, this is an important fact to build up trust by not only talk about work but also know what people around you feel or do in their free time. This makes you understand people better and get a better connection”.*

The participant used the term to socialize and stated that he needs to get into other people’s minds. Furthermore, he explained that extending the topic of talking to other people beyond business to a personal level and to know what people around are feeling helps to generate a better understanding of people and to improve the connection to people, activities the participant linked to the use of social skills. An improved connection to other people finally becomes a strategy for the participant to make things work. Hence the use of tacit knowledge in the form of o social skills builds here as well the central element.

Another participant also verbalised the need for a more personal contact to create trust by stating:

> *ATM33: “In the most matters I personally prefer the face-to-face meetings because I think the understanding is very easy to get. You can show pictures, you can look into the other person’s eyes and you can bring a lot of people together. There’s more personality in the room which gives more trust and confidence in the end”.*

The participant explains that he prefers face-to-face meetings and to look in the other person´s eyes. This personal contact enables the participant to generate more trust and confidence.

This statement shows that the participant is aware of his skills and that he applies his skills by interacting with people. The participant refers to the use of tacit knowledge in the form of social skills to generate more trust and confidence to bring people together and to make things work.

One participant described in the interview that attitude is important to her, for generating trust to solve problems and thus make things work:

> *ATW2: "But, I think, it is all about attitude. That's very important, because there are different attitudes around. And what you need for the programs is the attitude, that how can I help the program and what can I do to solve problems. This should be a main attitude to my point of view. It's not finger-pointing to people, never. I always avoid this. It's more than "Hey, there's an issue. Let's come together and let's talk about how to solve".*

This dialogue describes the creation of trust by giving the team a feeling of working together and not working against each other to solve problems and make things work. The process of giving a feeling to someone cannot be described in detailed explicit knowledge, but can be linked back to the use of empathy by the participant, which again stands for the use of tacit knowledge in the form of social skills.

From the above it is clear that a variety of activities that are supported, triggered or progressed by the use of tacit knowledge in the form of social skills by the participants in this organisation made it appropriate to give this sub-theme the broad header "Making things work". The variety of different activities related to the use of social skills by the participants in this organisation shows that the use of tacit knowledge in the form of social skills is mandatory to this organisation. By activities that are used to make things work like bringing people together, aligning people on a common goal, and making people perform, the use of tacit knowledge in the form of social skills builds the central element.

The majority of the participants prefer a personal interaction with people. The preference of the participants of being in personal contact with the people in the organisation is seen in this context as an indicator for the importance and the positive effect of using tacit knowledge in the form of social skills to make things work. Personal contact allows the participants to use tacit knowledge in the form of social skills in its "full range". Activities described by all participants like using and observing body language, talking to people while having eye-contact, abstract activities like feeling people or giving other people a feeling is only possible by being in personal contact with someone other.

Furthermore, it is recognised by the participants that the generation of trust is a central building block for working together. An environment of trust increases the share of information within the team, the quality of working together and the efficiency of working together which leads to

the overall result of making things work. The generation of trust was linked back to the use of empathy which again stands for the use of tacit knowledge in the form of social skills. Hence the use of tacit knowledge in the form of socials skills by knowledge workers in this organisation is an active element of making things work and with this to facilitate development work.

5.10.1.2 Social skills as a key for working together and building teams

Working in a team is recognized by the majority of the participants to be quite mandatory in this organisation to generate output. Output in this organisation cannot be generated by a single person. The generation of output is seen as a team goal which is based on experience and knowledge from all members:

> *ATM41: "So most of the time it's definitely a team effort. If I would not listen to other people's opinion, if I would not ask people from other departments for their buy-in or fresh eye review, then the result would be purely based on my thinking. But there are so many other people with intelligent knowledge here in the company. Knowledge that I don't have and for me it's important to respect that and gain their experience as well. Working in a team together, listening and being curious about what other people think is very important to me and consequentially to the result what I'm delivering".*
>
> *ATM30: "My lessons learned is that working together, even rather in smaller teams instead of bigger teams, is like a healthy "Klüngel" I can help someone and he would help me in exchange when I need him".* (Comment from the author: "Klüngel" is a regional saying for one hand washes the other.)
>
> *ATM7: "A complex product like an automobile can only be realized if you're in contact with a lot of teams and a lot of other specialists".*
>
> *ATW14: "My approach is that at the end of the day, we all need each other's help. And at the end of the day everyone has their own level of expertise or their own role in the project".*
>
> *ATM28: "80% of what we're actually doing is based on team work and works you can't do on your own. You need other people to do it, to resolve problems for example, which is the majority of our work but also to build a vehicle. Nobody of us has all the skills and knowledge to do it on your own so you need other people and there you need your social skills. And if you don't have good social skills, you will be rapidly alone. And being alone you can't be successful".*

Interacting with people, listening to people, and being open for other people are main attributes in this form of working together. These statements demonstrate that being part of a team, working in a team, and working as a team are related to the use of tacit knowledge in the form

of social skills. This circumstance is well recognized and verbalised from a majority of the participants by referring to the use of social skills in multiple examples with respect to the work in a team:

> *ATM19: "But also on all the other skill levels, for example if you don't have good social skills, you won't get the team working together or won't get the help from the team. You will maybe not get the information which are required to make your job right".*
>
> *ATW2: "That's why we need to establish good soft skills, to get all people on board and to communicate, give them directions but also working with them together and it's a big team".*

Tacit knowledge in the form of social skills is also used by the participants to harmonize team members to each other:

> *ATM28: "You can come to a situation where you need to take directions when you're in a different position. But that's all in the social part like talking good to people, bringing people together, manage conflicts when they're not harmonically working as a team".*
>
> *ATM37: "That's really a nursery job to evaluate upfront who is the critical person within the team and who is usually not following my guidance to deliver the result in a timely manner. For some people I use different skills to talk to them due to the fact that they're reluctant to do this job. I have to convince them to do the job and have to tell them the background story where I'm coming from to carry them throw the job".*

The comparison to a nursery job was used by the participant to explain his role, a role that describes someone who is patient with others, who guides, supports and helps others. This self-conception of the participants in these positions occurs frequently within the data and stands for the broad field of activities in which social skills are essential to performance. Using social skills stands for the use of tacit knowledge in the form of social skills.

Because of the complexity of the product that is developed in this organisation, the need for knowledge and experience is high. The multiplicity of knowledge and experience required in this organisation to generate output cannot be possessed by a single person. Hence working together as a team is essential in this organisation. Well recognized by the knowledge workers in this organisation, working in a team or being part of a team is, by the participants, frequently linked back to the use of social skills. This is further evidence shows that the use of tacit knowledge in the form of social skills seems to build the baseline for working together in this organisation. Hence, the use of tacit knowledge in the form of social skills to promote working together in a team is an essential element to facilitate development work in this organisation.

5.10.1.3 The use of social skills to establish networking

Networking is a broad approach of working together or working in a team. Networking takes place among employees across all departments, sections or fields in this organisation. It is well accepted that a single employee cannot possess all the knowledge that is required to conduct the whole development work in this organisation. Hence networking is used by the majority of the participants to compensate a lack of expertise. Furthermore, a network seems to increase efficiency in working together:

> *ATM23: "I'm having 25 years of company experience and all the people, friends, colleagues and enemies. Don't forget the enemies because they're useful as well to give bad examples. Therefore, it's important since it's a network for me and that's what I'm living from. It's not what I'm obviously learning, like day by day or on trainings, it's more like if I have an issue, I do know who I have to call to fix the issue. Or people are calling me with an issue and I maybe cannot answer or solve by myself, but then I know in this company, where the people are located who can help us to solve this issue. We're structured in the way that every single department is just handling a broken-down task to bring a vehicle together and people don't expect me to solve everything".*

> *ATM41: "Participant: Yes. I don't know if it's many compared to others. I'm here for 17 years now, starting with a job apprenticeship. All the people, who are working now in different parts of the company, I still know many of them. From time to time your path crosses again and then it's a very easy start. For example, if you go to someone here in the company who you don't know and you're just asking something out of curiosity, the first reaction in this company might be very often, that this person will not be very supportive. Especially if it's not a critical issue. But with my network and when you're asking someone from another department, then they're totally open and not critically rejecting you".*

The participant states that if someone is already known in the organisation it is easier to get the information or things you need, a circumstance linked back from the participant to the use of a network. This effect of a network was described by the majority of the other participant as well:

> *ATW13: "Yes. Because you just know the people from experience, from past. And then of course it's easier to get information you need or feedback, when you know the people. Also, when I get an email or a call or something from people I know, I answer differently or faster, when I know them as when I don't know them".*

ATM19: "In the social networking I gain most of my experience. Practical wise, when I started working in my job 7 years ago, I didn't know much about cars, but only the very general things. I was not educated in the field of automotive or vehicle engineering. That's why I definitely learned a lot in the practical and technical area which is crucial for the job of course".

Building up a network and using a network was by the participants always linked, to the use of social skills:

ATW14: "The challenge for me is that I'm not an engineer. Basically, my job is 90% talking to engineers. I think maybe I compensate for that lack of knowledge with working a lot on that networking and building up a relationship with that person. I always say that I need to build a relationship with that person for them to know they can talk to me on the same level but I need to be able to know I can ask stupid questions. It's all about kind of getting that relationship with that person and then feeling comfortable that we all know what we're playing and what we're doing".

ATM41: "Maybe we had some beer together before, we know each other for many years and things like that. Sometimes also outside the work environment. Networks and being open-minded helps to get everybody back to this common thinking that we want to do the same".

The statements from the participants are representative of the circumstance that networking is recognised from the majority of participants as a form of working together that helps to compensate for lacks of expertise and to increase efficiency. According to the patterns that emerged across the interview data, building and using networks in this organisation seems to be strongly related to the use of social skills. Therefore, the use of tacit knowledge in the form of social skills seem to be mandatory to build up and use networks in this organisation to compensate for a lack of expertise or to increase efficiency in interacting with people.

5.10.1.4 Social skills recognized as a required resource in the product development department

The majority of the participants identified social skills as the most important skill in their position. The need for technical skills was mentioned, but not justified to the extent or in the detail like activities around the use of tacit knowledge in the form of social skills. This can be possibly explained by the circumstance that for the majority of the participants the need to work together with people, to align people, and to convince people presents the central challenge in their position to finally make things work and to generate output:

ATW3: "I believe social skills are very important. As I said a big part of my work is communication and at the end where you see the result, you see that this is a product

of many many many different sub-projects and sub-parts which are all coming together in one result and one result is not possible without these millions of small pieces".

ATM8: "To the end result social skills are very important. Because you have to convince the decision maker to make the right decision. You wouldn't be able to do that if all you do would be reading from papers. It just wouldn't work".

ATW5: "I always mentioned social first because if you're not a social person you'll not be able to have any good results in this company. Alone in your office you will not be able to develop any solutions for problems or new items or technical stuff".

ATM12: "It's mandatory to have social skills, because without socializing you will not be recognized by other people. People will not get in touch with you later on because they would think "why should I get in touch with this guy if I don't have any benefit from it"?

ATM28: "Social skills absolutely crucial. 80% of what we're actually doing is based on team work and works you can't do on your own. You need other people to do it, to resolve problems for example, which is the majority of our work but also to build a vehicle".

ATM33: "I think that social skills is one of the key points. We're working in a big company and my job is to bring teams together. We all have to work together and use the same materials or factories for example. This can only work out if the social aspects are in good condition".

ATW7: "It is very important in my opinion, which is lucky for me. Otherwise I probably wouldn't be good in this job if it would only be about technical stuff".

ATW11: "I think without social skills you don't get an end result".

ATW6: "Without social network and without social skills I wouldn´t be able to work very well".

While technical skills were only mentioned, the majority of participants linked the use of social skills back to the end results of their work, underpinning the importance:

ATW13: "For me, social skills are very important. Because, basically the work is all about getting the people together or getting people to do what I need to get my product delivered. I think technical content is what everybody can do"!

The use of social skills is recognized by the majority of the participants as fundamental in this organisation. Using social skills stands for the application of tacit knowledge in the form of social skills.

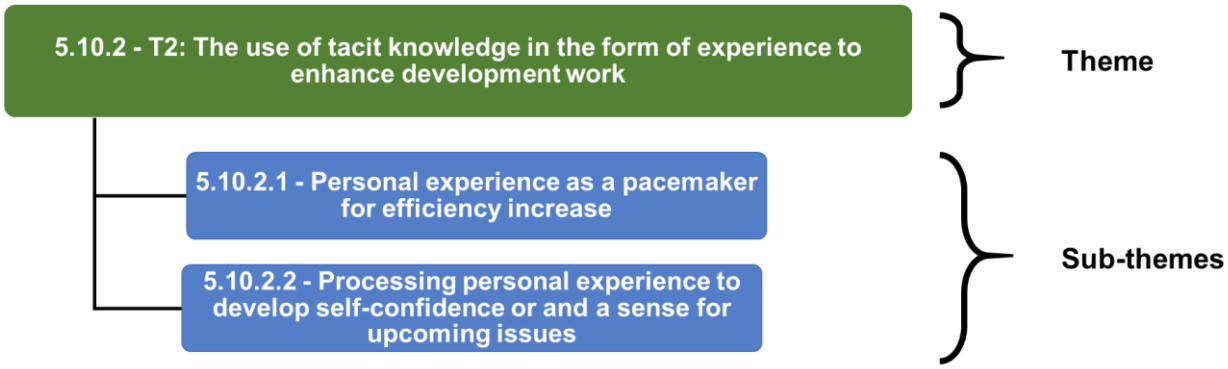
In conclusion it can be stated that the common perception of the participants that social skills are an essential element in this organisation can be seen as the result of applying tacit knowledge in the form of social skills by the participants to a variety of activities in this organisation. Activities as described in the sub-themes above that make things work, that are essential to work in a team, or develop and use networks. These activities are all based on the use of tacit knowledge in the form of social skills. Hence, the outlining of the sub-themes above demonstrates that the sum of the activities as part of the performance in this organisation finally facilitates development work in this organisation.

In addition to the use of tacit knowledge in the form of social skills as part of knowledge worker performance, the use of tacit knowledge in the form of experience builds an essential element of the performance of these workers. The next chapters focus on the use of experience to enhance development work in this organisation which builds theme T2 in this thesis.

5.10.2 Theme (T2): The use of tacit knowledge in the form of experience to enhance development work.

Figure 16 below shows an overview of theme T2 - “The use of tacit knowledge in the form of experience to enhance development work.” and the related sub-themes that are presented in this section.

Figure 16: Theme T2 and related sub-themes



Theme T2 - “The use of tacit knowledge in the form of experience to enhance development work.” is about the use of tacit knowledge in the form of experience to enhance development work in this organisation. The patterns in the data show that personally-obtained experience of the participants enables the majority of the participants to work more efficiently. Through personal experience participants increased their self-confidence or developed a feeling for specific situations. A feeling developed through personal experience is used by the participants

to handle specific situations in their daily business and with this to enhance development work. The sub-themes of this theme are used to structure its content, which avoids overloading the main theme and helps to tell the story of theme T2 to the reader without unnecessary complexity (Braun and Clarke, 2006). The following sub sections outline the sub-themes which form the main theme:

- Personal experience as a pacemaker for efficiency increase.
- Processing personal experience to develop self-confidence or and a sense for upcoming issues.

5.10.2.1 Personal experience as a pacemaker for efficiency increase.

The majority (n=19) of the participants stated that the personal experience they have obtained has helped them become more efficient in their role:

> *ATM3: "The more experience you gain, the better the next project can benefit out of your experience and the more efficient you might run that project".*
>
> *ATM41: "Based on the experience you can ensure that the product meets more requirements at the end for customers and other departments".*
>
> *ATM30: "My experience helps me to get the right decision in the right time".*
>
> *ATM12: "One thing is simply to have all processes done at least one time before. When you do it the second time you can a) make it better and b) you know earlier what you have to do and how it's correct".*

One participant described the process of working with personal experience he obtained by referring to an internal data storage:

> *ATM17: "Collecting or seeing issues, storing what was the root cause for the issues and how it has been resolved and making sure that these issues do not happen again. This is kind of an internal data storage".*

By referring to an internal data storage the participant demonstrates that he is able to use personal experience from former projects to increase efficiency. All of the participants are consciously linking personal-obtained experience with an increase in efficiency. The circumstance that the participants are conscious of the link between personally-obtained experience and an increase in efficiency shows that the participants have gone through a mental process where personal experiences are processed to enhance future challenges in the participants businesses. This circular mental process feeds itself and relates to the use of tacit knowledge in the form of experience.

Furthermore, participants recognized that the variety of experience plays an important role. Experiences related to only one specific task or field are less valued than experiences spanning the whole process of development. It seems that in terms of experience the "allrounder" who has a variety of experiences is able to generate a broader understanding and with this works even more efficiently:

> *ATW3: "I've not always been working in planning, I also worked in engineering, in electrical and I was working in resource planning. This background and experience from there is also very helpful for me. For example, when I'm communication with engineers in most cases I know what are their problems or issues because I've been working at the other side and I know how it is there".*

> *ATM41: "It's not a fault if a person has not been in the manufacturing area during his career but as I know, that for the people who are working there different things matter, I can improve my work here to and make their work better at the end as well and even vice versa".*

> *ATM23: "I had the pleasure to attend all the different steps from the start to the end of the process and on the current job this is very important for me because it helps me to understand where we're heading to".*

The participant *ATM23* also stated in the interview:

> *ATM23: "But due to the fact that I've changed my position and departments before, and I've learned different things there, I bring the experience together".*

This statement represents a common mental process all of the participants have gone through, an unconscious process of connecting personal experiences out of different departments, fields and activities to increase efficiency in their own and in organisational performance. This mental process stands for the use of tacit knowledge in the form of experience.

Another strong pattern that emerged across the whole data set is related to the importance of obtaining personal experience in the field of social skills used to increase efficiency:

> *ATM23: "You learn, by experience, to whom you're talking and you adopt your communication style to get at least an answer and, best case, help or the solution you like to have from this person".*

> *ATM8: "We've a lot of young engineers who come in and think they can be head of department as soon as they joint. But it's obvious that you can't, because these things like being able to talk to somebody who's older than you and who's got lot ore of experience is something that you need to gain experience in as well".*

ATM28: "Experience about working with people, talking to people and identifying the facts and the true story in the descriptions and story you hear from the people. Bringing people together, to show the way how to work together, establishing timing plans and work plans".

ATW9: "Experience also is to know how people from other countries or cultures behave and think. For example, I know from meetings that people from North America act a bit different compared to us in Europe. Therefore, it's good to have experience in this field and to know how to work and to act. That makes a lot of things easier".

ATW7: "Staying with the communicating, you get the experience of how to question if someone on the phone doesn't really get you to where you want. But, if you know how to speak to people, I guess they're better".

ATW13: "But also of course experience in communicating with the people. I know them or I know how people react and how I can best get what I need for the work to be done".

Developing or improving social skills through experiences to increase efficiency seems to build a central element in this organisation. The process of developing or improving social skills through experiences is a mental process which is deeply ingrained in the participants and builds on the use of tacit knowledge in the form of experience. Hence the use of tacit knowledge in the form of experience is interwoven to the development or the improvement of social skills.

This sub-theme captured the use of tacit knowledge in the form of personal experience by describing mental processes deeply ingrained in the participants, of developing new personal knowledge through the combination of personal experiences the participant obtained from different departments or activities. This new personal knowledge is based on the use of tacit knowledge in the form of experience and is used from the participants to increase efficiency in this organisation.

5.10.2.2 Processing personal experience to develop self-confidence or and a sense for upcoming issues.

This sub-theme outlines the effect of personal experiences on specific attributes of the participants. The majority of the participants commonly agree that personally-obtained experiences lead to an increase in self-confidence within in their roles:

TW2: "Because, within the time, based on my experience, I gain more confidence and what I can observe is that I also behave different within the time in regard of everything like meetings and presentation skills. Because you're gaining a routine and you don't get stressed so quick".

ATM28: "The experience gives you the confidence to do the job, to be patient and calm in critical situations, not to get nervous and not to exaggerate. Also, not to influence or impress people in a negative way".

ATW10: "Yes, for instance, the way that I can take decisions and I think that is evolved through the experience. And I think when you're a starter in this company, definitely I was not self-confident for instance, going into meetings and saying something. I think that has actually evolved over the time".

ATW13: "Now when I have the experience, I can stay calmer and I know, there are process steps or tools I can use. And I can get a proper plan communicated when I have it from the supplier and then here internally.

Interviewer: So you're creating some kind of confidence out of this experience?

ATW13: Yes".

The participant´s feeling of confidence that evolves through obtained experiences is a process where obtained experiences are manifested in the participant´s feelings. This manifestation can be seen as the result of using tacit knowledge in the form of experience by the participants. Some participants developed a further feeling through the use of tacit knowledge in the form of experience beyond the feeling of confidence. The feeling the participants referred to seem to be a feeling which is related to some kind of validity check in their business. Validity of data or process steps in the development process:

ATM37: "The translation from program content into output in terms of required number of prototypes and dollars. We have models in place to calculate all this and analytics, but if you're experienced enough you could even get a feeling before these tools are used which numbers could be correct and in which direction the result will go".

Another participant consciously linked this specific feeling back to a sensuous activity:

ATW2: "The sensuous part was that I asked for a special meeting because my feeling was "Hey, If we're not looking into this tomorrow or today, we'll get bigger issues than we expect." And this was really sensuous".

The mental process of the participants behind these examples seem to build on an unconscious judgement of a variety of variables linked to the specific context the participants are in. The circumstance that the participants refer to, a feeling or a sensuous activity to explain the judging in this event, demonstrates that the knowledge behind this process is tacit knowledge. The participants are not able to explicitly verbalise the knowledge they use for this activity and refer to a feeling. Based on the circumstance that the participants were able to link

experience to feeling, it can be argued that the participants refer in this context to the use of tacit knowledge in the form of experience. Hence, the statements are demonstrating that tacit knowledge in the form of experience enable the participants to develop a feeling for the correctness of data or to develop a sense for potential upcoming issues.

Participants in this organisation are increasing their own performance and the performance of the organisation and developing “detecting” feels through experiences. The process of using personal experience to generate new knowledge – knowledge that helps the participants increase their own effectiveness or the efficiency of the organisation or that helps the participants develop a “feeling” – is deeply mentally ingrained in the participants. The circumstance that the majority of the participants link back the increase of efficiency or the development of a feeling to personal experiences demonstrates that the participants are describing abstract mental processes based on the use of tacit knowledge in the form of experience. The use of tacit knowledge in the form of experience leads to an enhancement of development work in this organisation.

5.11 Using member checking to enhance credibility and to achieve trustworthiness

Before the final summary of the findings was created, the report was used to conduct member checking and to support trustworthiness in this research. Trustworthiness in qualitative research is addressed by Lincoln and Guba (1985) in the use of four criteria. These four criteria are credibility, dependability, transferability, and confirmability. Credibility is, according to Lincoln and Guba (1985), one of the most important criteria to achieve trustworthiness. Credibility is based on the steps the researcher has conducted to gather valid and relevant data (Lincoln and Guba, 1985; Shenton, 2004). Various strategies within these different research steps can be undertaken to ensure credibility (Shenton, 2004; Tuckett, 2005b). Lincoln and Guba (1985) classify member checking as the most important technique to underpin the credibility of a study. This section refers to the tool of member checking to support and to enhance credibility in this research.

Member checking helps to reduce researcher bias and with this to verify and to ensure trustworthiness in this research (Doyle, 2007). To enable the reader to determine the quality of the findings in this research, the process behind conducting of member checking and the results as output of the process are briefly summarized in this section. The outlining of other strategies that were applied as part of this research to meet the above-mentioned four criteria of trustworthiness and to establish trustworthiness are part of a later section in this work. Member checking can be conducted by the use of different techniques. Common frequently-used techniques are transcript checks or case summaries checks by the participants

(Goldblatt, Karnieli-Miller and Neumann, 2011; Birt *et al.*, 2016). All procedures are about getting back to some or all of the participants to review the collected data or the interpretative report along with illustrative quotes. The participants are asked for their judgement in terms of accuracy of the transcripts or their views and experiences with respect to the researcher´s interpretation (Goldblatt, Karnieli-Miller and Neumann, 2011), a procedure that supports or improves the researcher´s understanding of the phenomenon under investigation.

All member checking procedures are linked with potential issues and challenges. Carlson (2010) describes potential ethical issues when conducting member checks by returning transcripts. Participants can feel uncomfortable or stressed when they are confronted with the way they speak. Forbat and Henderson (2005) describe the return of transcripts as a situation that participants are not familiar with. Some of the participants may dislike the way they speak when they see it in written form and others would appreciate these kinds of insights. As a result of uncomfortable feelings, the participants might reject or request the deletion of the data that they do not like because of unusual formulation or word use (Forbat and Henderson, 2005; Doyle, 2007; Carlson, 2010). This effect can be avoided by using member check interviews or member check focus groups (Doyle, 2007; Koelsch, 2013; Birt *et al.*, 2016). By the use of these procedures, active interaction between the researcher and the participants take place. Discussion on the transcripts can help the participants handle this unusual situation; similar experiences of other participants exchanged in a focus group might generate a situation where participants feel confirmed in their experience by others (Koelsch, 2013; Birt *et al.*, 2016).

The ethical issues of these techniques are mostly related to the effect of coercion (Doyle, 2007; Koelsch, 2013; Birt *et al.*, 2016). The participant might feel dominated in the presence of the researcher and a disagreement from the participant to the researcher's interpretation could be hard. Group coercion can occur in focus groups. Single participants might avoid disagreeing with the position of the group.

Further challenges are seen with respect to the time and resource consumption of such exercises and the availability of the participants (Birt *et al.*, 2016). The decision to use which form of member checking should not rely on the advantages and disadvantages of a specific procedure. Birt *et al.* (2016) claim that the technique of member checking a researcher selects depends on the purpose behind the member check. It has to fit to the theorical position of the study. Arguments which guide the decision of the researcher in this study with respect to the identification of an appropriate procedure of member checking for this study.

The purpose behind member checking in this study is to determine if the results of this study are aligned with the experience of the participants. Birt *et al.* (2016, p. 1805) classify member checks with the use of analysed data from the whole sample as appropriate. Birt *et al.* (2016) refer to the technique of member checking of synthesized analysed data (SMC). While member

check interviews have congruence to the epistemology of constructivism, SMC is a method which is appropriate for a research with a the theoretical stance of a realist (Blaikie, 2007; Birt *et al.*, 2016). Hence, the purpose of the member checks as described above and the fact that this research is based on the theoretical stance of a critical realist, member checks in the form of synthesized data were identified as an appropriate procedure to support trustworthiness in this research.

Furthermore, the majority of the participants have requested feedback on the overall findings in this research. So the circumstance was helpful in two ways for the researcher (validation) and the participants (feedback). The researcher satisfied the request from the participants with respect to the feedback on the overall findings by sending out a concise report of the synthesized data, which made the participant felt good in terms of acceptance and motivated the majority of the participants to send response to the researcher. The concise report sent out via e-mail to the participants contained the researcher´s interpretations contextualized with illustrative quotations (find an example page of the concise report in the Appendix 9). All quotations were anonymized. The participants were asked in a cover letter to read the report and respond to the researcher if the interpretations of the data are in line with their experience or if they want to change anything or if they want to add further comments. It was emphasized by the researcher that the report is not finalized and that any requested changes from the participants could be incorporated. Ten working days were given as due date to respond to the researcher via e-mail. All twenty-two participants were contacted.

The response rate within the ten working days was 73% (n=16). The male response rate was 77% (n=10) and the women response rate was 67% (n=6). Overall, all participants agreed with the researcher´s interpretations and have stated that the interpretations are in line with their experience. No substantial changes were requested from the participants. In addition to their confirmation of the findings, the majority of the participants added some comments to their feedback, comments that were not directly related to the interpretations the researcher has made. These comments were linked to the personal experience of the participants during the process of interviewing. The participants stated in their feedback that they weren´t really conscious of their use of tacit knowledge before the interview.

> *ATM37*: *"I am using tacit knowledge that much in my role but before the interview I have just performed without being aware that my tacit knowledge enables me to perform in many cases".*
>
> *ATW11: "It was a great experience to meet my tacit knowledge source".*

The interviews helped the participants to become conscious of their tacit knowledge usage in their roles, an experience which was classified from the participants as enriching. The

circumstance that the possessor of tacit knowledge usage is not aware of its usage in the workplace is most often observed in the context of tacit knowledge usage research and is described in the literature (Polanyi, 1966; Smith, 2001). The results of this exercise and the transparency with respects to the decisions made to conduct member checking in form of synthesized data should enhance credibility in this research and should help the reader to judge the trustworthiness of the findings.

5.12 Trustworthiness in research step two

According to Ritchie and Lewis (2012, p. 270) the concepts of reliability and validity do not have their birth in qualitative research. These concepts stem from the domain of natural sciences, which refers to the positivist paradigm. A debate has been triggered in the literature about the applicability of the concepts of reliability, validity and objectivity with an origin in quantitative approaches and its value in the field of qualitative research (Amaratunga *et al.*, 2002; Shenton, 2004; Ritchie and Lewis, 2012). The reliability in qualitative research has become a stress point in science literature leading to the creation of alternative terms and concepts to address the same issues. Terms like trustworthiness, credibility, dependability, confirmability are used to address the process of proving reliability in qualitative research (Glaser and Strauss, 1967; Lincoln and Guba, 1985; Creswell and Miller, 2000; Ritchie and Lewis, 2012).

In the very essence of this discussion, independent from the approach or the philosophy that is used in a study, the above highlighted terms and concepts relate to the steps a researcher has undertaken to prove that the study process the researcher has gone through justifies the findings the researcher has made, a circumstance that describes the common agreement with respect to the operational purpose among all these different concepts and terms. To demonstrate rigour and soundness of the findings in this study, the researcher in this thesis followed the concept of trustworthiness from Lincoln and Guba (1985). Lincoln and Guba (1985) have addressed four criteria to ensure trustworthiness in research and to separate themselves from the positivist philosophy. The four criteria are credibility, dependability, transferability and confirmability. Credibility is based on the steps the researcher has conducted to gather valid and relevant data. The findings based on the data gathered must accurately present the participants perspective. Dependability is linked to the transparency the researcher has generated with respect to the study process. The researcher has to reflect on the occurrence of changes in the research setting that might have influenced the study process and the actions the researcher has carried out to cope with these challenges. Transferability describes the level to which the results of a study can be generalized or applied to other contexts. Confirmability stands for the degree to which the results of the study can be replicated

and achieved by other researchers. Table 16 below briefly summarizes for each of the four criteria the steps that were undertaken in this research to achieve trustworthiness:

Table 16: Applied strategies to ensure trustworthiness

Criteria:	**Applied strategies to ensure trustworthiness in this research step:**
Credibility	• Literature review of existing literature in the field of tacit knowledge (Bryman and Bell, 2015) • Research questions and research objectives are informed from the research context and refined according to existing gaps in the literature on tacit knowledge (Creswell, 2014; Bryman and Bell, 2015) • The use of well-established research methods in the field of research on tacit knowledge (Shenton, 2004; Yin, 2014) • Familiarity with the organisation where the research takes place – advantages of an inside researcher (Lincoln and Guba, 1985) • The use of random sampling approaches (Shenton, 2004) • Application of mixed methods (Shenton, 2004) • Activities to ensure honesty of the participants (Shenton, 2004) • Interviews and interview transcription carried out by the researcher himself and interview audio recorded (Shenton, 2004; Tuckett, 2005b) • Transcripts have been checked against the audio records (Braun and Clarke, 2006) • Appropriate approach of data analysis (Braun and Clarke, 2013) • Member checking (Gray, 2009; Bryman and Bell, 2015; Birt *et al.*, 2016) • Frequent alignment and debriefing meetings with both supervisor (Shenton, 2004) • Permanent peer scrutiny exercises of research progress and findings (Shenton, 2004) • Findings underpinned by quoted interview extracts (Braun and Clarke, 2006; Vivar *et al.*, 2007)
Dependability	• "Thick description" sufficient and contextual information of the research are provided (Lincoln and Guba, 1985) • Linking research findings with previous literature (Braun and Clarke, 2013; Silverman, 2017)
Transferability	• "Thick description" sufficient and contextual information of the research (research setting, participants information and findings) are provided (Lincoln and Guba, 1985; Firestone, 1993)
Confirmability	• In-depth methodological description (Shenton, 2004) • Research diary (Tuckett, 2005b) • Confirmability is the result of achieving credibility, transferability and dependability (Guba and Lincoln, 1989)

5.13 Summarizing the findings in research step two and answering RQ3 and RQ4

The findings in research step one have demonstrated that tacit knowledge in the form of skills experience, and abilities is frequently used by knowledge workers in this organisation. Research step two was carried out to further explore the use of tacit knowledge in the form of skills, experience, and abilities by knowledge workers in this organisation to answer research questions (RQ3) and (RQ4):

The patterns in the data have shown that tacit knowledge in the form of skills is mainly related to the use of social skills. Tacit knowledge in the form of social skills is applied by the majority of the knowledge workers to a variety of different activities in this organisation. These activities are within the field of interaction with other members of this organisation. This finding is supported by the statement of Insch, McIntyre and Dawley (2008, p. 567) that an understanding of how to act with others describes the social dimension of tacit knowledge. Puusa and Eerikäinen (2010, p. 312) state that tacit knowledge expresses itself in the form of interaction and collaboration of individuals. Interaction between individuals is essential to the innovation processes (Leonard and Sensiper, 1998). Since the creation of innovation is seen as a core component of the development work in this organisation, the use of tacit knowledge in the form of social skills builds an essential element of interaction in this organisation. By applying tacit knowledge in the form of social skills, the knowledge workers in this organisation make things work, bring people together, align people, convince people, work together in a team with people, build up and use networks. Wagner (1987) explains tacit knowledge that is required to manage others by referring to the skill of someone to interact with peers, which is in line with the findings in this research. Tacit knowledge in the form of social skills enables the knowledge workers in this organisation to successfully manage others by carrying out the above-mentioned activities in the field of interaction. The reason for the interaction based on the use of tacit knowledge in the form of social skills that was found in this context can be linked back to the type of work which is carried out in this organisation. The development work performed in this organisation builds on intellectual and cognitive processes, which, in essence, describes knowledge work (Drucker, 1959; Heerwagen *et al.*, 2004). According to Heerwagen *et al.* (2004), knowledge work is highly social and strongly related to conversation and interaction with others. Hence the use of tacit knowledge in the form of social skills by knowledge workers in this organisation to carry out the above-mentioned activities in the field of interaction with others, realises knowledge work. Herewith the use of tacit knowledge in the form of social skills is essential to the performance of this organisation.

It can be summarized that the sum of activities which are based on the use of tacit knowledge in the form of social skills, carried out by the knowledge workers in this organisation to realise

knowledge work, facilitates the development work in this organisation. Furthermore, it was found that the knowledge workers in this organisation linked back an increase in their job efficiency to their use of tacit knowledge in the form of social skills. Insch, McIntyre and Dawley (2008) proved in their study that higher social skills of a person lead to higher performance of this person, a statement that explains the finding of the relation between the recognised efficiency increase of a knowledge worker and the use of tacit knowledge in the form of social skills.

In addition to the finding that tacit knowledge in the form of social skills is used to facilitate development work in this organisation, the analysis of the data has led to a further finding. The data has shown that tacit knowledge in the form of experience is used by the knowledge workers in this organisation to enhance development work in this organisation. Based on personally-obtained experience, the knowledge workers were able to become more efficient in their roles. Experience from different sections within the organisation and from different situations, especially in the field of social interaction, are mentally processed by the knowledge workers in this organisation. “Mentally processed” stands for organizing obtained experience to enhance the knowledge worker´s business. Nonaka and Takeuchi (1995) refer to this process as internalization. Experience from different fields are internalized into the individuals tacit knowledge base and become valuable assets for the organisation (Nonaka and Takeuchi, 1995, p. 69). The ability of the knowledge workers to organise the obtained experiences in the way that these experiences can be used by the knowledge workers to generate skills and abilities for similar situations in other contexts relates to the use of tacit knowledge in the form experience. Puusa and Eerikäinen (2010) claim that the tacit component of experience, which is developed out of experience, is the ability to apply the right approach to the right situation, a statement that supports the finding in this thesis. The interview data have shown that the knowledge workers have often repeated this process of internalization. The application of tacit knowledge is not a one-way street. Each time the knowledge workers have gone through this process the knowledge workers increased their tacit knowledge base in the form of experience with respect to conducting this internalisation process. On one side, the knowledge workers are developing a know-how of processing obtained experiences and, on the other side they apply the new generated tacit knowledge in form of experience from other contexts to situations in this organisation to increase efficiency benefit in their work. Brown and Duguid (1998) claim that know-how comes out of the tacit insights of experience and that know-how is the ability to put know-what into practice. Such statements even more underpin the findings of this research that tacit knowledge in the form of experience builds a central element in processing such experience and to increase efficiency in this organisation.

Furthermore, the knowledge workers developed through obtained experiences an increase in their level of self-confidence within their roles. Thus, experiences obtained by these knowledge workers were mentally processed and manifested in their feelings, which can be explained by the characteristics of tacit knowledge. Haldin-Herrgard (2004, p. 14) states that “tacit knowledge affects the ability to act independent of activity and competence”. The use of tacit knowledge in the form of experience enables the knowledge workers in this organisation to handle challenges in different contexts, independent of their own activity and competence. Tacit knowledge in the form of experience enables the knowledge workers in this organisation to perform in situations without being in that exact same situation before. The ability to cope with new situations based on the use of tacit knowledge in the form of experience has become some kind of a swiss army knife for those knowledge workers. Efficient and universally applicable. The achieved success of using tacit knowledge in the form of experience was then manifested in an increase in the felt level of self-confidence of the knowledge workers.

Beyond this increase in self-confidence the knowledge workers also developed based on their experience a feeling for upcoming problems or the validity of a specific outcome. Garrick and Chan (2017, p. 875) state that tacit knowledge involves a sense of what is going on, supported by the findings in this research as well. The knowledge workers were able to sense upcoming issues in a process or to judge the validity of process outputs without launching any kind of investigations. By using this sense, the knowledge workers have shown that they are aware of what is going on in the organisation or in processes. Upcoming negatively-impacting issues in any fields could be avoided and validity checks of process outputs could be conducted sectionally and even faster. The knowledge workers have linked this ability to a feeling or a sense, without being able to further explain this ability. The reason that the knowledge workers were not able to further explain this ability is seen in the abstractness of tacit knowledge. “Tacit knowledge is abstract, but can be expressed in other forms than verbalisation” (Haldin-Herrgard, 2004, p. 14). Hence the abstractness of tacit knowledge made it difficult for these knowledge workers to verbally explain this ability, but the verbalised result with respect to the detection of upcoming issues and judgment of data validity expressed the use of tacit knowledge in the form of experience. Smith (2001) delivers an argument that further supports the finding above, claiming that tacit knowledge often resembles intuition. The feeling for an upcoming process issue or the validity of an output, that the knowledge workers developed based on experience appeared to the researcher as some kind of specific intuitive ability, an ability which resembles, intuition but could be explained by the researcher by the use of tacit knowledge in the form of experience. The statement from Smith (2001) and the circumstance that the knowledge workers were able to link back their felt increase in the level of self-confidence and their development of “detecting” feelings to obtained experiences underpins the use of tacit knowledge in the form of experience by knowledge workers in this organisation.

There is common agreement in the literature that tacit knowledge is based on or embodied in experience (Polanyi, 1966; Nonaka and Takeuchi, 1995; Fleck, 1996; Sternberg and Horvath, 1999; Gourlay, 2003; Haldin-Herrgard, 2004). Therefore, the relation between tacit knowledge and experience is evident. The development of tacit knowledge in the form of experience, as outlined above, is based on abstract mental activities of processing personal obtained experience, by knowledge workers in this organisation. The application of tacit knowledge in the form of experience by knowledge workers of this organisation to their daily business challenges led finally to an enhancement of the development work in this organisation.

In addition to the findings above and following the statement from Sternberg (1988, 1997) with respect to the nature of tacit knowledge, it can be stated that tacit knowledge in the form of abilities builds a central element in all of the above described activities. Sternberg (1988, 1997) claims that tacit knowledge is the practical ability to learn from and to solve problems with the aim of achieving a personal goal, a statement which summarizes the basic component of tacit knowledge in the form of abilities in this context. In this context tacit knowledge in the form of abilities is seen as the cognitive and intellectual ability of the knowledge worker to be able to develop or to improve skills and to organise experiences to create new knowledge.

The findings of research step two helped to answer the research questions RQ3 and RQ4:

RQ3: How is specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

The evidence presented in the analysis of the data in research step two have shown that tacit knowledge in the form of social skills is mainly used from the knowledge workers in this organisation to interact with other members of the organisation. In the work with teams or with networks; tacit knowledge in the form of social skills is frequently applied. Based on the multitude of activities where the use of tacit knowledge in the form of social skills takes place, the importance of using social skills is well recognized by the knowledge workers in the product development department. Tacit knowledge in the form of experience is frequently applied by knowledge workers to different processes within the organisation. Progress, quality and efficiency of internal processes are monitored and adjusted by the use of tacit knowledge in the form of experience. Furthermore, tacit knowledge in the form of experience is used by knowledge workers in this organisation to identify potential upcoming process issues or to judge data in terms of validity. The application of tacit knowledge in the form of abilities by knowledge workers in this organisation is seen in the performance of essential mental processes by those knowledge workers. Tacit knowledge in the form of abilities occurs in this context as cognitive and intellectual ability of the knowledge workers.

RQ4: What is the purpose for the application of specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

It can be summarized that the central purpose of the application of tacit knowledge in the form of social skills by knowledge workers in this organisation is the facilitation of development work. People are brought together, aligned on a common target, motivated and convinced to achieve a common goal. Things get done, networks are established and used. The sum of these different activities carried out by the knowledge workers in this organisation are all based on the use of tacit knowledge in the form of social skills and are applied to facilitate the development work in this organisation. The purpose of applying tacit knowledge in the form of experience is seen in an enhancement of the development work in this organisation. By using tacit knowledge in the form of experience the knowledge workers in this organisation increase the efficiency of their own performance and the performance of the organisation. Tacit knowledge in the form of personally-obtained experiences is applied by knowledge workers in different contexts or situations for the purpose of issue- and inefficiency – avoidance. The application of tacit knowledge in the form of abilities describes the cognitive and intellectual processes of the knowledge workers to develop or to improve skills and to create new knowledge through personal obtained experiences.

The use of tacit knowledge in the form of social skills, experiences and abilities cannot be separated from each other. Hence, the use of tacit knowledge is not related to a single activity or field. Tacit knowledge can be understood as the key to synergistic effects between skills, experiences and abilities which can be applied across a variety of activities carried out in the organisation with the effect of facilitating and enhancing development work. Such attributes of tacit knowledge make tacit knowledge to an essential resource in this organisation.

Chapter 6: Conclusion

The aim of this research was to identify specific tacit knowledge frequently used by knowledge workers in the product development department of a multinational car manufacturer and to further explore this tacit knowledge use by eliciting how and why it is used. This research used mixed methods and was conducted in two sequential steps.

The first step in this research describes a quantitative approach and helped to overcome the barrier of identifying tacit knowledge in this organisation. By conducting a quantitative content analysis on organisation internal job advertisements, the type of knowledge worker position with the highest demand for tacit knowledge use to perform in their position was identified. The type of position identified was based on the high amount of tacit knowledge usage classified as critical to the organisational performance in terms of knowledge loss due to elevated employee turnover. Furthermore, it was possible in this first step to determine specific tacit knowledge frequently used in this type of position. Tacit knowledge in the form of skills, experience, and abilities are frequently used by the knowledge workers in this type of position. Due to the frequency of usage of tacit knowledge in these forms, tacit knowledge in the form of skills, experience, and abilities were also classified as critical to the organisational performance. The loss of tacit knowledge in these forms due to increased employee turnover might lead to a decrease in the organisational performance.

The second research step in this sequential research used a qualitative approach. In the second research step, the use of tacit knowledge in the forms of skills, experience and abilities was further explored. Twenty-two semi-structured interviews with knowledge workers out of the critical positions identified in research step one were conducted. Thematic analysis was used to analyse the interview data and to contextualise the use of tacit knowledge in the forms of skills, experience and abilities to organisational activities carried out by knowledge workers identified as critical to the organisational performance in case of greater employee turnover.

None of the results of each research step was privileged. Rather, the second research step was based on the results of the first research step. Hence, every single step undertaken in this sequential research helped to enhance and to deepen the understanding of the use of tacit knowledge in this organisation.

The research questions in this work were answered based on the results of the conducted data analysis for each research step and were presented in previous chapters (see 4.7 and 5.11) in this thesis. Therefore, the following sections in this chapter are used to address the achievement of the objectives of the study and to summarize the study´s contribution to knowledge and to professional practice. Furthermore, personal reflections from the researcher

on the study are shared and recommendations for further research in the field of research on tacit knowledge are made.

6.1 Achieving the research objectives in this study

The following four objectives were used to achieve the aim of this study:

1. To quantify tacit knowledge usage of knowledge workers in the product development department of the multinational auto manufacturer.
2. To identify specific tacit knowledge that is frequently required for performance by knowledge workers in the product development department of the multinational auto manufacturer.
3. To identify the contexts where specific tacit knowledge is frequently used by knowledge workers in the product development department of the multinational auto manufacturer.
4. To analyse the aim behind the use of tacit knowledge by knowledge workers within the product development department of the multinational auto manufacturer.

6.1.1 Achieving the first research objective

The need for this research is seen in the risk for potential knowledge loss in German organisations due to greater employee turnover within the next ten years. An aging workforce, early retirements and an increase in the share of temporary workforce are seen as the major triggers for greater employee loss. De Long and Davenport (2003) recommend the identification of knowledge critical to the organisation as a first step for establishing sufficient knowledge retention actions.

The literature review has shown common agreement that tacit knowledge is widely acknowledged as an essential element of business success and a crucial advantage for any enterprise (Nelson and Winter, 1982; Sternberg and Wagner, 1987; Nonaka and Takeuchi, 1995; Grant, 1996b; Brown and Duguid, 1998; Sparrow, 1998; Birchall and Tovstiga, 1999; Sternberg *et al.*, 1999; Busch and Richards, 2004; Rashid, Bin Hassan and Al-Oqaily, 2015; Sliwa and Patalas-Maliszewska, 2015; Dudek and Patalas-Maliszewska, 2016; Jisr and Maamari, 2017). Hence, the literature review helped to identify tacit knowledge as knowledge that is critical to the PDD.

The first research objective aims to quantify tacit knowledge usage of knowledge workers in the PDD. By applying the concept of ETK developed from Haldin-Herrgard (2003) in the context of quantitative content analysis, the researcher was able to quantify the amount of tacit knowledge usage required to perform in different knowledge worker positions. The content of eighty-four job advertisements of knowledge worker positions from four different salary groups from a three-year period were analysed with respect to the use of epitomes of tacit knowledge. The AT salary group was the salary group with the highgest average of used epitomes (9,7)

followed by EG14 (8,0), LL6 (6,4) and EG13 (5,0). The number of used epitomes correlates with the amount of tacit knowledge necessary to perform in positions in this salary group, a correlation corroborated by the methodology from Haldin-Herrgard (2003). Based on the result from this analysis it was possible to classify the knowledge workers in the PDD according to their tacit knowledge usage. Knowledge workers of the AT salary group were identified as critical resources because these workers hold the greatest amount of tacit knowledge in the case organisation. The achievement of the first objective allowed the narrowing of the field of this research to knowledge worker positions in the PDD that are related to highest usage of tacit knowledge.

6.1.2 Achieving the second research objective

The second objective is to identify specific tacit knowledge that is frequently required for performance by knowledge workers in the product development department of the multinational auto manufacturer. The application of the concept of ETK developed from Haldin-Herrgard (2003) to this context enabled the researcher to identify specific tacit knowledge that is frequently used from knowledge workers in the PDD. Tacit knowledge in the form of the ETK skills, experience, and ability is most frequently used in the PDD. This finding confirmed the findings from the Haldin-Herrgard (2003) study. The Haldin-Herrgard (2003) study also identified these epitomes as most commonly used ETK. For further investigation of the usage of specifically identified frequently applied tacit knowledge forms, thematic analysis was employed in the form of semi-structured interviews. The intent of the interviews was to elicit the meaning behind the frequently used forms of tacit knowledge in the case organisation. The analysis revealed that tacit knowledge in the form of skills is related to the use of social skill by knowledge workers to interact with members of the organisation. Tacit knowledge in the form of experience is applied in the field of efficiency improvements and problem avoidance. The application of tacit knowledge in the form of abilities enables the knowledge workers to process obtained experience. Achieving this objective helped to concretise the understanding of the usage of the frequently applied tacit knowledge forms by product development department knowledge workers, therewith generating deeper understanding of the phenomenon researched.

6.1.3 Achieving the third research objective

The third objective aims to identify the contexts where specific tacit knowledge is frequently used by knowledge workers in the product development department of the multinational auto manufacturer. By applying thematic analysis to the interview data, the researcher was able to situate the use of tacit knowledge by knowledge workers in the form of skills, experience and abilities in the activities carried out in this organisation. Tacit knowledge in the form of social skills is applied by knowledge workers in the case organisation by interacting with members of

the organisation, motivating, or aligning members of the organisation, working in a team and developing networks. Tacit knowledge application in the form of experience is related to quality and efficiency topics of internal processes, the identification of potentially upcoming process issues and the judgement of data in terms of validity. Tacit knowledge in the form of abilities refers to the cognitive and intellectual processes of a knowledge worker in the PDD. Based on the fact that tacit knowledge is context dependent, the achievement of the third research objective is realized in the revealing of the related activities behind the application of these frequently used forms of tacit knowledge in the case organisation.

6.1.4 Achieving the fourth research objective

The fourth objective is to analyse the aim behind the use of tacit knowledge by knowledge workers within the product development department of the multinational auto manufacturer. The results of the conducted thematic analysis helped to link the use of tacit knowledge in the form of skills, experience and abilities to the activities and the purpose behind these activities carried out by the knowledge workers in the PDD. The aim of applying tacit knowledge in the form of social skills is the facilitation of development work. Members of the case organisation are brought together, oriented toward a common target, motivated and convinced to achieve a common goal. Networks are established and used; things get done. The application of tacit knowledge in the form of experience focuses on increasing efficiency. Individual and organisational performance is increased and the development work is enhanced. Finally, the application of tacit knowledge in the form of abilities enables knowledge workers to go through intellectual and cognitive processes with the aim to generate new knowledge. Achieving the fourth objective helped to elicit the purpose behind the application of tacit knowledge in the form of skills, experience and abilities in the context of the development department of a multinational car manufacturer.

6.2 Contribution to theory and practice

The review of the existing literature has shown that research on tacit knowledge is less often conducted compared to research on explicit knowledge. Research on tacit knowledge is still underrepresented and the growth for research on explicit knowledge is still dominant (Brown and Duguid, 1998; Holtshouse, 1998; Leonard and Sensiper, 1998; Zack, Rand and Wilsh, 1999; Garcia-Perez and Mitra, 2007; McAdam, Mason and McCrory, 2007). Since tacit knowledge is context related, the potential for application of tacit knowledge research results from other studies to other contexts is limited (Polanyi, 1966; Johannessen, Olaisen and Olsen, 2001; Gourlay, 2006; Garcia-Perez and Mitra, 2007; Insch, McIntyre and Dawley, 2008; Zhi *et al.*, 2016). The context relation of tacit knowledge permits that the contribution of this research to theory and to practice is methodological rather than absolute knowledge. A contribution to absolute knowledge cannot be achieved in this thesis because the specific context-related

characteristics of tacit knowledge and the aim of this research do not support a generalizable truth. Hence the context in which tacit knowledge is applied makes the meaning behind the application of specific tacit knowledge unique. The methodological contribution of this research addresses the challenge of the identification and the management of tacit knowledge in theory and practice. A persistent mental barrier in research on tacit knowledge which is verbalized from the majority of the authors in the field of tacit knowledge and is still necessary to overcome in conducting research on tacit knowledge (Polanyi, 1966; Nonaka and Takeuchi, 1995; Fleck, 1996; Ford and Sterman, 1997; Brown and Duguid, 1998; Nonaka and Konno, 1998; Gore and Gore, 1999; Zack, Rand and Wilsh, 1999; Gourlay, 2003; Seidler-de Alwis and Hartmann, 2008; Zhi *et al.*, 2016). The next two sections outline how the methodological contribution of this research might affect the theory and practice.

6.2.1 Contribution to knowledge

The literature review delivered only a few studies on tacit knowledge in organisations in the automotive sector. The paucity of tacit knowledge research in the automotive sector reveals a need and an opportunity for research and contribution to stem the potential knowledge outflow in the automotive manufacturing sector, a loss which could lead to near-future pitfalls in organisational performance (Ball and Gotsill, 2011). While Jafari, Akhavan and Nourizadeh, (2013) call for further research on tacit knowledge in the automotive sector, this research heeds as well for the call from Kabir (2013) to generate new knowledge in making tacit knowledge available by the identification of tacit knowledge resources in organisational data. Kabir (2013) argues that the pool of data available in an organisation contains a massive amount of tacit knowledge that can be extracted and analysed to improve organisation performance. Kabir (2013) refers here to technologies in the field of big data and data handling likely to emerge in the near future. Kabir (2013) did not deliver any concrete concept, methodology, or techniques to handle such a challenge.

Firstly, this research contributes a methodological approach to identifying tacit knowledge usage by knowledge workers in the case organisation by analysing organisational data and, in so doing, fills a gap in literature as requested from Kabir (2013). The ETK concept developed from Haldin-Herrgard (2003) was used to employ quantitative content analysis on available organisational data to elicit tacit knowledge usage. It turned out that internal job advertisements are rich in data relevant to the use of tacit knowledge in a position. Thus, this research used an existing theoretical concept in a practical new context to make use of quantitative content analysis to identify tacit knowledge in organisational data and filled a gap in literature on the elicitation of tacit knowledge in organisational data within the automotive sector. Due to limited evidence of validity of the work from Haldin-Herrgard (2003) it has to be emphasized that the methodological contribution is also limited to the identification and the mapping of tacit

knowledge application in organisations. For further exploration of the specific meaning behind the application of tacit knowledge in an organisation, the combination with further methodologies is absolutely necessary.

Secondly, new knowledge about how epitomes of tacit knowledge (ETK) can be conceptualized to act as construct for managing tacit knowledge in an organisation as requested by McAdam, Mason and McCrory (2007). McAdam, Mason and McCrory (2007) have recognized the potential of using epitomes of tacit knowledge to manage the use of tacit knowledge. The call for future research from McAdam, Mason and McCrory (2007) on the use of ETK to manage tacit knowledge represents the gap in the existing literature on using ETK to manage tacit knowledge. The scientifically well-accepted ETK framework of Haldin-Herrgard (2003) enables the identification and mapping of tacit knowledge. Further research to develop new knowledge on how ETK can be used to manage tacit knowledge was not found. This research developed new knowledge on the use of ETK to manage tacit knowledge by applying the concept of ETK to organisational data and as a result answered the call made by McAdam, Mason and McCrory (2007). It was demonstrated that the concept of ETK can be used in the context of content analysis to quantify the amount of tacit knowledge required in different knowledge worker positions. The results from the content analysis helped to classify knowledge worker positions according to the amount of tacit knowledge required by knowledge workers to perform in their positions. Furthermore, the results from the quantitative content analysis in the first research step helped to identify frequently applied tacit knowledge in these positions, these are further explored by the administration of semi structured interviews in the second research step in this thesis. Based on these results, the organisation can prioritise the application of knowledge protection actions or can launch trainings, workshops, and processes to retain, improve the diffusion throughout the organisation of the identified tacit knowledge frequently used in the organisation. Herewith is the use of ETK in the context of quantitative content analysis on organisational data considered an appropriate approach for managing tacit knowledge in an organisation.

Thirdly, new knowledge with respect to the potential of using mixed methods in research on tacit knowledge in organisations: Although most of the studies in research on tacit knowledge in organisations are based on two sequential steps - the identification of tacit knowledge and the further exploration of tacit knowledge - a dominant approach in the literature in research on tacit knowledge in organisations could not be identified. While the application of mixed methods in research on knowledge is very limited (Massaro, Dumay and Garlatti, 2015), this research has shown that the use of mixed methods in research especially on tacit knowledge in organisations has great potential. The use of mixed methods appropriately facilitates the strategy of applying the above-highlighted two sequential steps used in most of the studies in

research on tacit knowledge in organisations. This result questions the low number of studies in the field of knowledge carried out by using mixed methods and underpins the potential of using mixed methods for research on tacit knowledge in organisations. Furthermore, the combination of a quantitative and a qualitative approach allowed the researcher in this study to deepen the exploration of the phenomenon tacit knowledge and to increase the understanding of tacit knowledge usage in organisations, supporting even more the use of mixed methods in research on tacit knowledge in organisations.

Fourthly, Sumbal *et al.* (2017) and Holtshouse, (2010) call for the development of an approach to assessing possible knowledge loss risks in the event of employee loss. Both have verbalised the increased knowledge loss risk to enterprise in the era of baby-boomer retirements. They claim that future research to identify knowledge in organisation should not only help organisations to assess the risk for possible knowledge loss, it should ultimately help establish appropriate knowledge retention strategies to avoid performance issues in such organisations. The methodological contribution of using ETK in the context of quantitative context analysis of internal job advertisements can help an organisation to classify the positions in an organisation according to the amount of tacit knowledge required to perform these positions. Based on this classification, the risk of possible knowledge loss and the impact of employee turnover on the performance of an organisation can be assessed. Due to importance of tacit knowledge to organisational performance; minimizing the impact of knowledge loss in employee turnover in positions with a high amount of required tacit knowledge is seen as critical to organisational performance (Nelson and Winter, 1982; Sternberg *et al.*, 1995; Grant, 1996a; Spender, 1996; Baumard, 1999; Gore and Gore, 1999; Smith, 2001; Jafari, Akhavan and Nourizadeh, 2013).

Fifthly, new knowledge on the importance of tacit knowledge to the performance of an organisation: There is common agreement in literature on tacit knowledge that tacit knowledge is essential to organisational performance (Nelson and Winter, 1982; Sternberg *et al.*, 1995; Grant, 1996a; Spender, 1996; Baumard, 1999; Gore and Gore, 1999; Smith, 2001; Jafari, Akhavan and Nourizadeh, 2013). The statements in the literature about the impact of tacit knowledge on the organisational performance do not refer to tacit knowledge in a specific form. Pathirage, Amaratunga and Haigh (2007) claim that the level of exploration of tacit knowledge based on skills and experience versus the level of exploration of explicit knowledge is considered as low. This research offers a first clear understanding of how tacit knowledge in the form of social skills, experiences, and abilities is applied from knowledge workers to organisational activities in the automotive sector and how these activities impact organisational performance. Tacit knowledge in the form of social skills is used to facilitate development work. Members of the case organisation are brought together, focused toward a common target, motivated and convinced to achieve a common goal. Things get done, networks are

established and used. Tacit knowledge in the form of experience is used to increase efficiency in a multitude of activities. By the application of tacit knowledge in the form of experience knowledge workers can self-navigate and successfully perform in areas or fields that are new or infrequently approached. Individual and organisational performance is increased and the development work is enhanced. Tacit knowledge in the form of abilities is related to cognitive and intellectual processes by knowledge workers to generate new knowledge. The findings in this research indicate that especially tacit knowledge in the form of social skills, experience and abilities are essential to the performance of an organisation.

6.2.2 Contribution to professional practice

The results of the research offer different benefits for the development department of the multinational car manufacturer. The main contribution of this research to practice is seen in the development of a methodological approach to assess the application of tacit knowledge in this organisation. This methodological approach can be used by the organisation as a tool for multiple management tasks around the use of tacit knowledge in this organisation. The following sections outline the results of this research by describing the potential opportunities that might impact the professional practice:

Firstly, based on the results of the research it is now transparent to the organisation which level of knowledge worker require the highest amount of tacit knowledge to perform in their positions. A classification of knowledge worker positions based on the amount of tacit knowledge required to perform in these positions was made and can be used by the organisation to assess the risk of tacit knowledge loss by employee turnover in these knowledge worker positions. The feedback on the report of the results to the management has shown that the perception of the management with respect to the requirement of tacit knowledge application in the different positions supports the results of this research. The management classified AT levelled workers as most important resources in terms of tacit knowledge application and the impact on organisational performance. A circumstance that confirmed by the results of this research. Furthermore, management response indicates that the research results confirm a restructuring strategy that has already been launched in the organisation by the management. This strategy contains the reduction of LL6 positions and also the conversion from LL6 positions to AT positions. The goal behind this strategy is to increase the efficiency in organisational performance by reducing management positions (in this case LL6 positions) and giving back responsibility to workers, which is realized by the conversion approach. Thus, this research delivered a scientifically-based confirmation to management for the launched strategy to reduce specific management positions and to convert these positions to positions in which the demand for tacit knowledge application

develops the skills and experience of knowledge workers with an eye toward increasing organisation performance and efficiency.

Secondly, based on the classification of knowledge workers according to the amount of tacit knowledge these workers possess, the organisation is now able to prioritize knowledge transfer actions to reduce the risk of tacit knowledge loss due to greater employee loss. AT-level workers are possessing the highest amount of tacit knowledge and were therefore classified as most critical to the performance of the organisation. Knowledge transfer actions should be prioritized to these positions to reduce the risk of decreasing performance of the organisation in case of greater employee turnover. Thereafter, knowledge transfer measures with EG14, LL6, and EG13 level workers follow respectively. Because tacit knowledge is best transferred by apprenticeship, practical experience, and intensive social interaction, like face-to-face interaction, this prioritization helps to manage resources for establishing such knowledge transfer actions efficiently (Polanyi, 1966; Nonaka and Takeuchi, 1995; Dyer and Nobeoka, 2000; Haldin-Herrgard, 2000).

Thirdly, the results of this research demonstrate that tacit knowledge in the form of social skills is used to facilitate the development work in this organisation. A multitude of activities carried out by knowledge workers that are essential to the performance of this organisation are based on the use of tacit knowledge in the form of social skills. Considering that the use of tacit knowledge is linked to the competitive advantage of an organisation and that this research demonstrates that tacit knowledge in the form of social skills is frequently used in this organisation to facilitate development work, the organisation might benefit from supporting employees in developing tacit knowledge in the form of social skills (Brown and Duguid, 1998; Leonard and Sensiper, 1998). Competitive advantages of the organisation might be improved.

Fourthly, the role of tacit knowledge in the form of experience in this context was linked to an enhancement of the development work in this organisation. Knowledge workers with a multitude of business experience from different departments increased the efficiency of their own performance and the performance of the organisation because of their application of their tacit knowledge in the form of experience. Hence these findings indicate that organisation should support knowledge workers in obtaining personal experience in different sections of the organisation, stimulating the broader development of tacit knowledge in the form of experience for knowledge workers with an eye toward increasing the efficiency in this organisation.

Fifthly, although tacit knowledge research is context related, the similarities of these results to those of the Haldin-Herrgard (2003) research – the importance of tacit knowledge application in the forms skills, experience, and abilities for achieving organization goals – might be realistically expected to be applicable to achieving goals in other organisations or sectors. The meaning behind these forms might vary between different organisations but the potential for

increasing organisational performance and strengthening competitiveness through conscious application of these forms of frequently used tacit knowledge elements should be considered by other organisations that are focused on improving their knowledge management and retention activities.

6.3 Research limitation and suggestion for future research

As with any research, this research also has limitations. Based on the author´s holistic understanding of his research, the next paragraphs are used to create transparency with respect to the limitations of this study. The author´s recognized limitations highlighted below are to help the reader generate an understanding of how the single characteristics of this research setting might have affected this research. This section should allow the reader to interpret the valuable results of this research in the light of its limitations.

The first limitation is with respect to the generalizability of the results of this research to knowledge workers of other organisations in the field of product development in the automotive sector. Based on the fact that tacit knowledge is context related; the results of this research might not be relevant for knowledge workers of other organisations in the field of product development (Polanyi, 1966; Nonaka and Takeuchi, 1995; Gourlay, 2003; Gascoigne, 2013). Future research may extend this research by selecting knowledge workers from other organisations and other sectors and comparing their results with results of this research to add another piece to the puzzle of understanding the use of tacit knowledge in organisations.

The second limitation is in the design of this research. This sequential research employed a cross-sectional design which, in the second research step involved semi-structured face to face interviews. Hence the data gathered in these semi-structured interviews represent a specific point in time. The answers given by the participants can be affected by different factors like their current role, current experience, current working atmosphere or their current private personal situation, just to name a few factors which have possibly influenced the participants answers. Future research can mitigate this limitation by conducting a longitudinal study. An approach which might improve the trustworthiness of their study.

The third limitation is a potential distortion issue. By translating the epitomes of tacit knowledge from English to German, distortion is possible. As explained in 4.1.1 to apply the concept of ETK from Haldin-Herrgard (2003) to organisational data (job advertisements written in German), it was necessary to translate the epitomes of tacit knowledge from English to German. Haldin-Herrgard (2003, p. 102) classifies this step as essential and called the step of translating the epitomes, “preparation of tools”. To guarantee equivalence of translation and to minimize the issue of distortion, the author used back-translation (Brislin, 1970; Baker, 2006). Future research can avoid this potential issue by using organisational data already created in

English. Furthermore, the author must highlight that the quality richness of data in job advertisements in this organisation is extremely high. As described in 4.2, a six-eye principle ensures the quality and the richness of data in the process of creating an internal job advertisement in this organisation. Other organisations that may not be using such a process and may lack in rigour and quality in the content of their job advertisements. Therefore, future research has to assess the quality and content of organisational data before applying the concept of epitomes of tacit knowledge in quantitative content analysis to organisational data to further explore the use of tacit knowledge in an organisation.

The fourth limitation is seen in the limited number of academic studies on tacit knowledge in the automotive sector. The literature search provided little guidance with respect to the use of approaches and strategies to identify and explore tacit knowledge usage in organisations in the automotive sector. Hence the literature on studies in research on tacit knowledge in the automotive sector is not extensive enough to deliver evidence of which approaches and strategies are most appropriate to identify and to explore tacit knowledge in organisation in the automotive sector. Further research on tacit knowledge in organisations in the automotive sector is needed to carry forward the idea of identifying the most successful approach or strategy to explore tacit knowledge in organisations within the sector.

It has been recognised in section 4.7 that there might be a positive correlation between the level of income and the need for tacit knowledge. In the scope of job advertisements used in this research related to specific income levels, the number of used epitomes in internal job advertisements correlated positively with income level. Future research may focus on this potential correlation by extending the field of investigation to further income levels and with this to contribute further knowledge on the relation between organisational factors and the use of tacit knowledge.

Finally, this research has shown that job advertisements are an important source of data in an organisation. Future research may concentrate on the development of an approach and a process to create job advertisements based on the use of epitomes of tacit knowledge. The creation of job advertisements based on the use of defined epitomes of tacit knowledge within a straight and reproduceable process can help to classify employees based on their need for tacit knowledge application in related position. This is a call for future research in such a direction, a call whose various forms of fulfilment may hold great payback benefits in the field of organisational knowledge management.

6.4 Personal reflections

Doing this research was a great challenge to the researcher. The author perceived the process of carrying out this research as a journey that developed the author in different fields. Insights

in the world of research changed the whole thinking and perception of the author with respect to his environment. The author learned that the world and all its events, happenings and phenomenon's might be explained along the philosophical continuum between a positivist stance and an interpretivist stance; whereas the explanation itself can be different depending on the philosophical stance. So, there is not really a right or wrong view of the world and its amazing phenomenon; it is always a context-related truth. This has become an essential experience for the author, which extended the author´s mental horizon. This is seen as a personal benefit that will from now on accompany the researcher in his daily life.

Reflecting on how this research was developed, the author can state that the process behind this development started with the awareness that German enterprises are facing potential knowledge loss due to greater employee turnover within the next ten years. This research was informed by an extended literature review that has elicited the importance of tacit knowledge usage to the performance of an organisation. The increasing risk for knowledge loss in organisations, the recognized importance of tacit knowledge usage in an organisation, and the finding that the literature review has shown that tacit knowledge receives much less attention in the research than explicit knowledge: the factors motivated the author to do this research.

The knowledge the author gained from the study of research philosophies, research methods, and research approaches served as a tool kit for the author to create an appropriate research strategy for research on tacit knowledge in the context of this organisation. While the abstractness of tacit knowledge builds the main barrier to research on tacit knowledge, the author understood this as a personal challenge to overcome. The extended literature review helped to generate, step by step, a deeper understanding of tacit knowledge and enabled the author to overcome the above-mentioned barrier and to develop a research strategy that addressed the aim of this research. During this research the author´s structural and analytical thinking abilities have broadened and increased, evolving through the multitude of decisions in this research made by the author. Decision were related to the identification of an appropriate approach to elicit tacit knowledge, to the identification of an appropriate research strategy to achieve the aim of this research, to the identification of knowledge and resources that are critical to the performance of an organisation, and, finally, decisions related to execution of this research. While the findings from the literature review were used as a theoretical launch pad for this research; the right combination of research methodology, the right approach of data gathering, and the right method of data analysis resulted from a constantly personal development of the author´s knowledge and research skills. Using an existing approach in a new research strategy and new research context and generating results that extend the existing knowledge in the field of research on tacit knowledge are achievements that confirm the improvement of the author´s research skills during this research.

Based on the findings in this research, the author realized the power of tacit knowledge in terms of making things work and achieving personal or business objectives in this organisation. The author is absolutely convinced that tacit knowledge usage is the decisive factor for improving business success. The results of this study have demonstrated how tacit knowledge contributes to the development work in this organisation. While the obvious reason for performance in this engineering-dominated organisation is assumed within concrete engineering knowledge, the underlying pacemaker of performance in this organisation stems from the use of tacit knowledge. Uncovering this result makes the author an ambassador of tacit knowledge usage in the PDD with the personal aim to increase the acceptance of tacit knowledge and the recognition of its hidden potential as knowledge resource for the performance of the PDD.

Finally, the author can state that the journey that has started with this research has not finished yet. Rather it would be right to say that the author is now equipped with improved research skills, improved writing and communications skills, improved analytical and critical thinking and improved problem-solving skills, an intellectual backpack that prepares the author for doing the right things and raising the right questions to further explore the use of tacit knowledge whenever its required.

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Appendix 1: Epitomes of tacit knowledge identified by Haldin-Herrgard (2003)

1.	Ability	47.	Attitude
2.	Skills	48.	Beliefs
3.	Embodied knowledge	49.	Common beliefs
4.	Collective ability	50.	Opinion
5.	Capability	51.	Perspectives
6.	Crafts	52.	Predictions
7.	Bodily skills	53.	Judgment
8.	Cognitive skills	54.	Estimation
9.	Communication skills	55.	Percept
10.	Coordination skills	56.	Personal experience
11.	Inductive skills	57.	Common in experience
12.	Managerial skills	58.	Pattern of experience
13.	Negotiation skills	59.	Best practice
14.	Operational skills	60.	Knowledge base
15.	People skills	61.	Masters sureness of action
16.	Physical skills	62.	After-the-fact awareness
17.	Social skills	63.	Artistic vision
18.	Intuition	64.	Care-why
19.	Intuitive	65.	Common sense
20.	knowledge Insight	66.	Creativity
21.	Flashes of insight	67.	Culture
22.	Non-analytical behaviour	68.	Embedded knowledge
23.	Flashes of inspiration	69.	Get a feel for
24.	Unconscious norms	70.	Emotional knowing
25.	Hunch	71.	Genres
26.	Shared beliefs	72.	Group's sense
27.	Automatic knowledge	73.	Improvisation
28.	Mental models	74.	Inexplicable mental processes
29.	Organizational memories	75.	Inner competence
30.	Shared meaning	76.	Instinctive reactions
31.	Cognitive schemes	77.	Personal competence
32.	Organizational mind	78.	Routines
33.	Thinking in practice	79.	Routinized knowledge
34.	Know-how	80.	Rule-of-thumb
35.	Expertise	81.	Sense making
36.	Collective know-how	82.	Shared values
37.	Practical intelligence	83.	Talent
38.	Life examples	84.	Taste
39.	Oneness of body and mind	85.	Techniques
40.	Know in ones body	86.	Tricks
41.	Feels as….	87.	Thoughts
42.	Looks as….	88.	Understanding
43.	Feeling	89.	Values
44.	Gut-feeling	90.	Sounds of
45.	Norms	91.	People knowledge
46.	Shared norms	92.	Shared code

Appendix 2: Epitomes of tacit knowledge classified into groups of affected activities

Mental	Sensuous	Social	Practical
Ability	Feeling	Common beliefs	Know-how
Skills	Skills	Skills	Skills
Cognitive skills	Bodily skills	Communication skills	Physical skills
Coordination skills	People skills	Managerial skills	Bodily skills
Inductive skills	Emotions	Negotiation skills	Operational skills
Managerial skills	Artistic vision	Social skills	Collective know-how
Negotiation skills	Taste	People skills	Skillful
Intuition	Attitude	Shared values	Best practice
Intuitive Knowledge	Gut-feeling	Values	Rule-of-thumb
Mental models	Unarticulated preferences	Shared meaning	Practical intelligence
Insight	Get a feel for	Culture	Tricks
Flashes of insight	Emotional knowing	Norms	Crafts
Flashes of inspiration	Oneness of body and mind	Shared norms	Ability
Mental Maps	Know in ones body	Common sense	Pattern of experience
Cognitive schemes	Looks of…	Life examples	After-the-fact awareness
Organizational mind	Sound of…	Group's sense	Automatic knowledge
Sense making	Feel of…	Social institutions	Intimation
Beliefs	Care why	People knowledge	Masters sureness of action
Creativity	Instinctive reactions	Shared code	Non-canonical practices
Judgment	Group's sense		Routinized knowledge
Opinion			Thinking in practice
Hunch			Life examples
Organizational memories			Genres
Perspectives			Improvisation
Talent			Routines
After-the-fact awareness			Techniques
Inexplicable mental processes			
Percept			
Predictions			
Sense making			
Estimation			
Knowledge base			
Thoughts			
Understanding			

Holistic
Inner competence
Personal competence
Non-analytical behaviour
Second nature
Experience
Talent
Common in experience

Source: Haldin-Herrgard (2004, p. 12)

Appendix 3: Translated epitomes

1	Ability	Fähigkeit; Können; Eignung; Qualifikation; Geschick
2	Skills	Fertigkeiten; Fähigkeiten; Kompetenz; Geschick; Kenntnis
3	Embodied knoweldge	In Wissen verkörpert; die Verkörperung des Wissenstands
4	Collective capability	Kollektive Fähigkeit;
5	Capability	Fähigkeit; Können; Befähigung; Tauglichkeit; Leistungsfähigkeit; Vermögen
6	Crafts	Handwerk; Fertigkeit
7	Body skills	Körperkompetenzen
8	Cognitive skills	Kognitive Fähigkeiten
9	Communication skills	Kommuniaktionsfähigkeiten
10	Coordination skills	Koordinatiosfähigkeiten
11	Inductive skills	Induktive Fähigkeiten
12	Managerial skills	Management Fähigkeiten, Managementkompetenz
13	Negotiation skills	Verhandlunsgeschick
14	Operational skills	Operative Fähigkeiten
15	People skills	Soziale Kompetenz
16	Physical skills	Körperliche Fähigkeiten
17	Social skills	Soziale Fähigkeiten
18	Intuition	Intuition
19	Intuitive	Intuitiv
20	Knowledge insight	Wissen Einblick
21	Flashes of insight	Gedankenblitz
22	Non-anayltical behaviour	Automatische Gedanken; reflexive Reaktion; reflexives Benehmen/Verhalten; Aktivitäten oder Gedanken oder Äußerungen; die nicht überlegt oder über logische Methoden erreicht sind.
23	Flashes of inspiration	Gedankenblitz
24	Unconscious norms	Unbewusste Normen oder Glauben
25	Hunch	Ahnung
26	Shared beliefs	Geteilte Überzeugung; gemeinsamer Glaube
27	Automatic knowledge	Latentes/schlaffendes/schlummerndes/verborgenes/gebundenes Wissen
28	Mental models	Geistige Modelle; Mentale Modelle
29	Organizational memories	Erinnerungen oder Gedächtnisse einer Genossenschaft oder einer Gruppe oder einer Gemeinschaft; Gruppengedächtnisse
30	Shared meaning	Gemeinsame Bedeutung
31	Cognitive schemes	Verhaltensmuster
32	Organizational mind	Gruppengedanken; Gruppenverstand.
33	Thinking in pratice	Praktisches Denken
34	Know-how	Fachwissen; Know-How
35	Expertise	Sachverstand; Expertise; Expertenwissen
36	Collective know-how	Kollektives Know-how; Schwarmintelligenz
37	Pracitical intelligence	Praktisches Denken; Pragmatisch;
38	Life examples	Lebensbeispiele
39	Oneness of body and mind	Einheit von Körper und Geist; Ganzheitlichkeit des Mensches
40	Known in ones body	Körpergefühl ganzheitlich
41	Feels as	Fühlt sich an als
42	Looks as	Sieht aus als
43	Feeling	Gefühl
44	Gut-Feeling	Bauch-Gefühl
45	Norms	Normen
46	Shared norms	Gemeinsame Normen

47	Attitude	Haltung
48	Beliefs	Überzeugungen; Glaube(n); Normen; Grundkenntnisse
49	Common beliefs	Gemeinsame Überzeugungen (religiöus und säkular)
50	Opinion	Meinung
51	Perspectives	Perspektiven
52	Predictions	Vorhersagen
53	Judgement	Beurteilung
54	Estimation	Einschätzung
55	Perception	Wahrnehmung
56	Personal experience	Persönliche Erfahrung
57	Common experience	Gemeinsame Erfahrung
58	Pattern of experience	Muster der Erfahrung; Erfahrungsverhältnisse;
59	Best practice	Best Practice; Musterlösung; bestes Verfahren; bewährte Methode; Standardanweisung
60	Knowledge base	Wissensbasis; Wissensprofil; Grundlagenwissen, Basiswissen
61	Master sureness of action	Handlungssicher
62	After-the-fact awareness	Nachträgliche Erkenntnis oder Bewusstsein
63	Artistic vision	Kreativer Blick; künstlerische Vorstellung oder Darstellung
64	Care-why	Zuneigung für etwas empfinden; Mitfühlen
65	Common sense	Gesunder Menschenverstand
66	Creativity	Kreativität
67	Culture	Kultur
68	Embedded knowledge	Eingebettetes Wissen
69	Get a feel for	Ein Gefühl für etwas haben oder entwickeln oder kriegen
70	Emotional knowing	Emotionale Intelligenz; emotionale Weißheit; emotionales Wissen
71	Genres	Genres
72	Group´s sense	Gruppensinn; Gruppengedanken; Gruppenverstand/-weißheit
73	Improvisation	Improvisation
74	Inexplicable mental processes	Unerklärliche mentale Prozesse
75	Inner competence	Innere Kompetenz
76	Instinctive reactions	Instinktive Reaktion
77	Personal competence	Persönliche Kompetenz
78	Routines	Routinen
79	Routinized knowledge	Routiniertes Wissen
80	Rule-of-thumb	Faustregel
81	Sense making	Sinn machen
82	Shared values	Gemeinsame Werte oder Prinzipien oder Standards oder Grundsätze oder Normen)
83	Talent	Talent
84	Taste	Geschmack
85	Techniques	Technicken
86	Tricks	Tricks
87	Thoughts	Gedanken
88	Understanding	Verstehen, Verständnis
89	Values	Werte
90	Sounds of	Töne von; klingt wie; Klang des/der
91	People knowledge	Menschenkenntnis; Menschenwissen
92	Shared code	Gemeinsame Vorschriften oder Normen ; Kodifizierung/Kodifikation

Appendix 4: Overview random samples

LL6					
2015		2016		2017	
Adv. ID	Random Number	Adv. ID	Random Number	Adv. ID	Random Number
10531	0,00073201	11359	0,018129046	11658	0,06659515
10642	0,008347535	11417	0,213615778	11702	0,08399146
10659	0,017545835	11469	0,317946512	11730	0,099842909
11257	0,04242284	11505	0,32963761	11765	0,253870221
11280	0,17415734	11523	0,393250431	11772	0,38362205
11290	0,321750768	11585	0,452417869	11794	0,470868134
11302	0,466390954			11815	0,556000768
				11826	0,59641804
EG13					
2015		2016		2017	
Adv. ID	Random Number	Adv. ID	Random Number	Adv. ID	Random Number
10299	0,282454167	11319	0,044663989	11683	0,019336615
10402	0,437291447	11322	0,126571507	11692	0,03093398
		11407	0,321578047	11738	0,092752905
		11507	0,392448824	11757	0,101720973
		11528	0,415592511	11762	0,155694743
		11536	0,529084798	11775	0,188212815
		11565	0,63697356	11806	0,237251407
				11844	0,305964809
				11853	0,335315752
				11874	0,338490031
				11879	0,647752133
				11931	0,725557926
EG14					
2015		2016		2017	
Adv. ID	Random Number	Adv. ID	Random Number	Adv. ID	Random Number
9932	0,00033103	11321	0,004086123	11613	0,003465399
9945	0,016831593	11381	0,012960981	11678	0,004984821
11189	0,08127894	11296	0,032867303	11686	0,006047538
11225	0,130724001	11415	0,033685037	11698	0,010744993
		11501	0,074379212	11707	0,021122497
		11533	0,079937544	11771	0,034307399
		11548	0,083262243	11800	0,042702867
				11836	0,055386726
				11883	0,06713359
				11925	0,073393277
AT					
2015		2016		2017	
Adv. ID	Random Number	Adv. ID	Random Number	Adv. ID	Random Number
9944	0,056364886	11357	0,200172417	11662	0,016518681
10004	0,103756565	11435	0,223165897	11680	0,081648698
10316	0,14170585	11458	0,263925063	11685	0,181491059
10332	0,1557933	11510	0,309348618	11695	0,188786331
10327	0,198223631	11515	0,309732119	11715	0,364154252
11281	0,256975299	11520	0,408782986	11768	0,436111704
		11576	0,46405713	11869	0,461125118
				11911	0,52268301

Appendix 5: Example of a job advertisement reviewed in this research

Appendix 6: Official job descriptions for EG13 and EG14

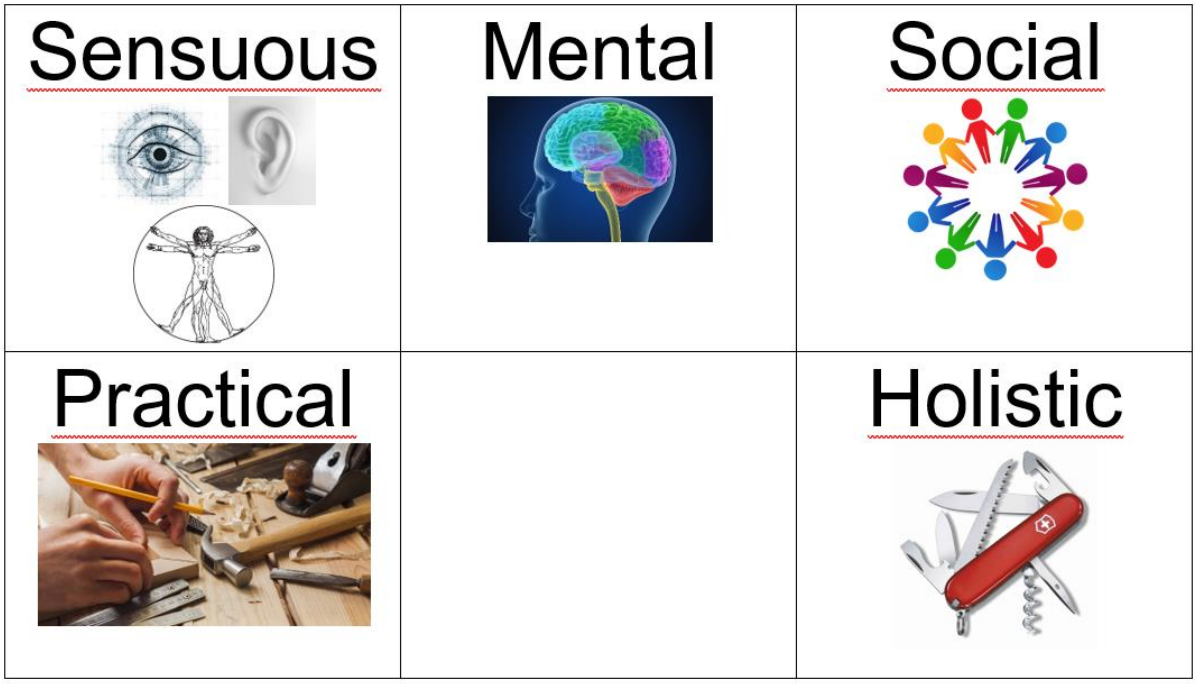
Appendix 7: Cohen´s kappa calculation to prove interrater reliability

		Coder Two									
		0	1	2	3	4	5	6	7		
Coder One	0	1427	1	0	0	0	0	0	0	1428	77%
	1	0	309	1	0	0	0	0	0	310	17%
	2	0	1	47	0	0	0	0	0	48	3%
	3	0	0	7	42	0	0	0	0	49	3%
	4	0	0	0	3	6	0	0	0	9	0%
	5	0	0	0	1	0	1	0	0	2	0%
	6	0	0	0	0	0	0	1	0	1	0%
	7	0	0	0	0	0	0	0	1	1	0%
		1427	311	55	46	6	1	1	1	1848	
		77%	17%	3%	2%	0%	0%	0%	0%		

k = (PR(a)- Pr(e)) / (1 - Pr(e))

Pr (a)	**0,99**
Pr (e)	**0,63**
k	**0,98**

Appendix 8: Material to support interviewing – Fields of Activities



Appendix 9: Example page of concise report used for member checking in this study

The use of tacit knowledge in the form of social skills to facilitate development work.

The researcher recognized by frequently occurring patterns in the data that the use of tacit knowledge in the form of social skills by participants of this organisation builds a central topic in this organisation. A multitude of activities as part of the development work carried out in this organisation are strongly related to the use of tacit knowledge in the form of social skills. Tacit knowledge in the form of socials skills triggers and supports development work. A circumstance that was verbalised from the participants by referring to specific activities. Activities like working together, building up teams, motivating people, convincing people, communicating with people or developing and using network could be traced back to the use of tacit knowledge in the form of social skills. The sum of activities carried out by the participants based on the use of tacit knowledge in the form of social skills facilitates development work in this organisation.

"We are combining and getting people from different departments together. We're linking them to each other, so it's important that you know how to communicate and bring people together". – The right way to talk to people, to get in contact with people and to bring people together was from the majority of the participants classified as essential for their work. The verbalised activities behind talking or communicating with people can be seen as activities that refer to the use of tacit knowledge in the form of social skills to achieve progress.

"You need to talk to the people as a friend or as a daddy, a good daddy of course and not a top-down daddy". – Participants compared their roles in the organisation to the role of a daddy, friend or a nanny. Roles that are describing that the participants feel responsible to make the things work by bringing the team together, make them understand that they have a common goal and guide the people into the right direction.

" Without emotion, bring the team together to work". - Without emotion means in this context to be able to work with every person in the team beside any personal differences or to be able to compensate personal stress or absorb upcoming tension during the process of development and not give it back to the team. The reduction of other people's stress by working together with these people was highlighted by the majority of the participants. Tacit knowledge in the form of social skills helped to handle such situations by using the right approach of communication or behaviour in these situations.

Appendix 10: Ethical approval

The study obtained ethical approval from the University of Worcester Ethics Committee (HASSREC).

References:

- Research Step 1 – HASSREC CODE: HCA17180073
- Research Step 2 – HASSREC CODE: CBPS18190005-R

Appendix 11: Case study protocol

Change Log

Date	Section	Update
Aug 18	Oververview of the Case Study	Added: Embedded Single Case Study Design
March 2019	Data Collection Questions	Interview Questions Added
May 2019	Data Collection Procedures	Added: Sample criteria for data gathering step 2

Overview of the Case Study

1. **Problem:** Potential loss of knowledge in German organisations due to greater employee leavings within the next ten years.
2. **Decision for selecting the PDD:** The PDD was selected because this organisation is a knowledge intensive organisation
3. **Mission / Aim:** The aim of this research is to identify specific tacit knowledge that is frequently used by knowledge workers in the product development department of a multinational car manufacturer and to further explore the tacit knowledge usage by eliciting how and why it is used.
4. **Research questions:**
    a. RQ1: How does the usage of job-related tacit knowledge differ between knowledge workers in different positions within the product development department of a multinational automotive manufacturer in Germany?
    b. RQ2: What specific tacit knowledge is frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?
    c. RQ3: How is specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?
    d. RQ4: What is the purpose for the application of specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?
5. **Theoretical framework**
    a. Embedded Single Case Study Design
    b. Mixed Methods (1st Research Step Quantitative and 2nd Research Step Qualitative
    c. Key readings:

Case Study	Yin (2014), Creswell (2012), Meyer (2001), Gray (2009), Eisehardt and Graebner (2007)
Tacit Knowledge	Polany (1958, 1966), Nonaka (1994), Brown and Duguid (1998), Nonaka an Takeuchi (1995), Grant (1996), Herrgard (2003, 2004), Sternberg (1995, 2000, 2003)
Quantitative Content Analysis	Krippendorf (2013), Silverman (2014), Harris (2001), Potter and Levine-Donnerstein (1999); Kondracki, Wellman and Amundson (2002)
Thematic Analysis	Braun and Clarke (2006), Boyatzis (1998), Denzin and Lincoln (2005)
General Research Guidance Lit.	Brymann and Bell (2015), Saunders and Lewis (2016), Gray (2009)(Saunders, Lewis and Thornhill, 2016)

6. **Purpose:** This protocol was developed according to the recommendations made by Yin (2014, p. 84). It is used as standardized roadmap to conduct this research and to improve reliability of the results.

Data Collection Procedures

1. **Ethical considerations**
    a. Ethical approval for each step of data gathering required from the University of Worcester (HASSREC).
    b. Authorization from HR and Working Council for each step of data gathering required.
2. **Identification of data sources and expected type of evidence**
    a. Internal job advertisements – Epitomes of Tacit Knowledge (ETK)
    b. Knowledge worker (member of the organisation) – Deeper insides on tacit knowledge frequently used in this organisation
3. **Administrative preparation**
    a. 1st Research Step – Request access to digitalized internal job advertisements - (Contacts: HR and Working Council)
    b. 2nd Research Step – Conducting interviews with knowledge workers in this organisation (Contacts: HR, Working Council and Colleagues)
4. **Data collection and analysis**
    a. 1st Research Step – Random sampling - Review of internal job advertisements based on quantitative content analysis.
    b. 2nd Research Step – Random sampling - Data gathering by conduction of semi-structured interviews and data analysis by the application of thematic analysis.
        - Sample criteria for step 2 of data gathering:

Stage of data collection	Sample type	Inclusion criteria	Exclusion criteria
Step two of data gathering	Employees of the multinational car manufacturer	Base heads of the multinational car manufacturer	Non-base heads / agencies
		Salary - Level: AT	Deviating to inclusion criteria defined salary levels
		Job experience: > 3 years	Employees with job experience less than 3 years
		Area of employment: Product development - Merkenich / Cologne	Area of employment: Non-product development - Merkenich / Cologne
		Region of employment: Germany -> Merkenich / Cologne	Region of employment: Non-Germany -> Merkenich /Cologne

Data Collection Questions

a. **To be answered by the results of the 1st Research Step -** RQ1: How does the usage of job-related tacit knowledge differ between knowledge workers in different positions within the product development department of a multinational automotive manufacturer in Germany?
   - Is there a pattern of distribution of tacit knowledge among the knowledge workers in the PDD?
   - What are the differences in the job description among the different levels of income?

b. **To be answered by the results of the 1st Research Step -** RQ2: What specific tacit knowledge is frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?
   - What is the range of used ETK among all reviewed job advertisements?
   - Which ETK are frequently used?
   - Any similarities among all reviewed job advertisements?

c. **To be answered by the results of the 2nd Research Step -** RQ3: How is specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

d. **To be answered by the results of the 2nd Research Step -** RQ4: What is the purpose for the application of specific tacit knowledge frequently applied by knowledge workers in the product development department of a multinational automotive manufacturer in Germany?

e. **Interview question for the 2nd Research Step related to tacit knowledge frequently used in the PDD:**

	Question	Aim
Skills	Q1: What meaning has skill to you in your work?	To identify patterns of perception and meaning of skills between the different participants overall positions. This will help to generate an understanding of the participant´s perception and meaning of skills in his or her position.
	Q2: What kinds of skills are required in your work?	To generate an understanding which specific skills are mainly affected / needed in the participant´s position. This will help to understand the commonality or difference with respect to the requirement for specific skills overall participants and positions.
	Q3: Which skills are really important to you and why?	To generate an understanding of the importance of specific skills and the arguments behind the classification of importance. This will help to identify abilities required from a knowledge worker to perform in the PDD and to identify patterns of skills which are classified as really important in the context of the participants between all participants overall positions. The answers will enable the researcher to link specific skills with the use of tacit knowledge.
	Q4: To which of the following activities would you locate your skills in the context to your position and why? (Sensuous, Mental, Social, Practical, Holistic)	To locate skills according to the field of activities defined by Haldin-Herrgard (2003). This will help to define fields of activities in the organisation where skills are related to a high usage of tacit knowledge.
	Q5: How important are skills to the end results of your work?	This question helps to detect any kind of inconsistency to the answers of the questions Q1 to Q3. Perception of inconsistency by the researcher can be an indicator of insufficient understanding of respondent's answers. This question is a chance for the researcher to raise additional questions and to guarantee the right understanding of the answers given from the participants.
	Q6: Can you give me an example of the importance of skills in your work?	To enable the researcher to put the answers from the questions above into the context of this example. This will help to unearth further details on the importance of skills and abilities and the interdependencies between skills and abilities as well the use of tacit knowledge which weren´t detected during the questioning before.

	Question	Aim
Experience	Q7: What meaning has experience to you in your work?	To identify patterns of perception and meaning of experience between the different participants overall positions. This will help to generate an understanding of the participant´s perception and meaning of experience in his or her position.
	Q8: What kinds of experiences are required in your work?	To generate an understanding which kind of experience are helpful in the participant´s position. This will help to understand the commonality or difference with respect to helpful experience overall participants and positions and to link specific experience with the use of tacit knowledge.
	Q9: In which of the following activities in the context to your position do you gain most of your experience and why? (Sensuous, Mental, Social, Practical, Holistic)	To understand in which field of activities defined by Haldin-Herrgard (2003) gained the interviewee most of his or her experience. This will help to identify abilities required from a knowledge worker to perform in the PDD and identifies the activities in the organisation which are linked to high usage of tacit knowledge.
	Q10: How important are experiences to the end results of your work?	This question helps to detect any kind of inconsistency to the answers of the questions Q7 and Q8. Perception of inconsistency by the researcher can be an indicator of insufficient understanding of respondent's answers. This question is a chance for the researcher to raise additional questions and to guarantee the right understanding of the answers given from the participants.
	Q11: Can you give me an example of the importance of experience in your work?	To enable the researcher to put the answers from the questions above into the context of this example. This will help to unearth further details on the importance of experience and the interdependencies between experience and the use of tacit knowledge which weren´t detected during the questioning before.

Appendix 12: Guide for the case study report

a. Audience for the report: University
b. Tacit knowledge usage in the PDD
c. Context of tacit knowledge usage and activities carried out by knowledge workers in the PDD.
d. Recommendations for prioritizing the introduction of knowledge retention actions.