Keeping the Wheels of the Automotive Industry Turning: The Use of Tacit Knowledge by Product Development Workers in a Multinational Automotive Manufacturer

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Abstract

Purpose

This research identifies the forms of tacit knowledge frequently requested in the job descriptions of knowledge workers in a multinational automotive manufacturer's product development department. It then explores how and why the most requested forms of tacit knowledge are used in practice to achieve organizational goals.

Design/methodology/approach

This study follows a sequential mixed-methods approach to quantify the most frequently requested forms of tacit knowledge within internal job descriptions and then explores how and why this tacit knowledge is used. The first stage applies manifest content analysis to internal job descriptions to highlight the epitomes of tacit knowledge to identify the most frequently requested forms of tacit knowledge. The second stage employs semi-structured interviews to explore the use of the most frequently requested forms of tacit knowledge in practice.

Findings

The research indicated that the organization most frequently requested tacit knowledge in the form of skills and experience in the job descriptions of knowledge workers in the product development department. When the use and application of tacit knowledge in the form of skills were further explored in practice, it was found that tacit knowledge-based socially-focused skills were used, which was underpinned by the need to bring people together and

align them towards a common goal to make things work; by enabling people to work together as a team; by developing and using networks; and acting as a required resource to support the development and integration in product development. Tacit knowledge in the form of experience was applied through the application of personally obtained experience to enhance development work by acting as a pacemaker for increasing efficiency and a sense of upcoming issues.

Originality

This work addresses the paucity of studies identifying tacit knowledge in large organizations and meets calls to investigate the processes and activities related to tacit knowledge in specific contexts.

Keywords

Tacit Knowledge, Knowledge Workers, Automotive Manufacturer, Automotive Engineering, Product Development

Introduction

The retirement of older experts presents a risk of organizational knowledge loss in knowledge-intensive companies (Levy, 2011; Joe et al., 2013). The transfer and potential loss of tacit knowledge have been highlighted as a challenge for engineering companies with aging workforces (Letmathe and Rößler, 2019). Workers over 50 make up 35 percent of the German workforce (Statistik Bundesagentur für Arbeit, 2018). Partial retirement programs and increased sick leave of these older employees will intensify in German companies in the next ten years (Dachverband der Betriebskrankenkassen, 2016). Employee turnover is further rising due to the increased use of temporary workforce in companies. For example, 691,000 employee positions were filled by temporary workers, while 717,000 temporary workforce contracts were terminated in the second quarter of 2015 (Bundesagentur für Arbeit, 2018). Departing employees take with them tacit knowledge crucial to an organization's successful operation (Polanyi, 1958). German companies face a loss in tacit knowledge due to increased employee turnover.

Tacit knowledge is knowledge based on an individual's experience and includes intuition, beliefs, and insights (Polanyi, 1966). Verbalisation of tacit knowledge is difficult, making tacit knowledge hard to identify, store, and transfer to another (Fleck, 2014; Seidler-de Alwis and Hartmann, 2008). Tacit knowledge is widely acknowledged as an essential element of business success and a crucial advantage for any enterprise (Jisr and Maamari, 2017). Research on tacit knowledge is limited relative to explicit knowledge (Leonard and Sensiper, 1998), which can be captured using information technology (Seidler-de Alwis and Hartmann, 2008). Conversely, tacit knowledge is difficult to store, verbalize, or transfer; it is personal and context-related (Nonaka and Takeuchi, 1995; Gascoigne, 2013). Kabir (2013) expresses the need for research that enables an organization to identify tacit knowledge resources in organizational data. Sumbal et al. (2017) call for the development of measures that identify potential organizational knowledge loss through employee turnover and establish knowledge retention guidelines. Managing knowledge to achieve knowledge transfer and retention in an organization requires identifying critical knowledge that is essential to organizational performance (De Long and Davenport, 2003; Levallet and Chan, 2019).

One way to identify the critical tacit knowledge in a company is by understanding the use of tacit knowledge. This research examines the most frequently requested forms of tacit knowledge in the job descriptions of knowledge workers in the product development department (PDD) of a multinational automotive manufacturer based in Germany. It then explores how and why the most requested forms of tacit knowledge are used in practice to achieve organizational goals. The research uses the PDD as a unit of analysis and provides a contextualized understanding of tacit knowledge usage by utilizing an epitome–based research approach suggested by McAdam et al. (2007).

The PDD employs well-educated 'knowledge' workers who perform non-routine tasks requiring thought and decision making (Choi and Varney, 1995). Knowledge workers are distinguished from traditional workers by their autonomy and a lack of boundaries in their activities (Scarbrough, 1999). An organization's knowledge worker is argued to be an essential resource; their knowledge is a critical part of the foundation on which an organization builds. A knowledge worker specifically uses tacit knowledge to perform successfully in changing fields of activity (Blackler, 1995; El-Farr, 2009). Hence, concentrating on knowledge workers' tacit knowledge in this research will examine the essential organizational knowledge sources. The intellectual core competencies in the studied PPD are the processing and generation of new knowledge from which the organization can benefit, that is, new products, innovations, and efficiency-increasing processes and the creation of intangible organizational value. It has been highlighted that tacit knowledge is essential for knowledge creation in the automotive industry (Canonico et al., 2020), making the PDD an excellent unit for research.

Despite its importance to a firm, there remains a dearth of research on tacit knowledge (McAdam et al., 2007). Kabir (2013) expresses the need for knowledge that enables an organization to identify tacit knowledge resources in organizational data. Differences in research outcomes among different contexts and countries due to the individual character and cultural relations of tacit knowledge (Gourlay, 2004; Gascoigne, 2013) underlie the need for more research in the field (Venkitachalam and Busch, 2012). Hadjimichael and Tsoukas (2019) call for a more contextualized understanding of tacit knowledge. Given these gaps in the literature on tacit knowledge and the clear need for more contextual insight, the purpose of this research is to identify what forms of tacit knowledge are frequently requested by a

multinational automotive manufacturer, of the knowledge workers in the PDD, and provide an understanding of 'how' and 'why' these are used in practice to support new product development. This paper answers the question: What forms of tacit knowledge are frequently requested by the organization of the product development knowledge workers? It then answers: How and why is this form of tacit knowledge applied by these knowledge workers? Answering these questions will help move the field forward by meeting calls to investigate what processes and activities tacit knowledge are related to within specific contexts (Hadjimichael and Tsoukas, 2019). Organizations need to retain their tacit knowledge base to support the development of new products to compete with lower-cost international competitors. This has been highlighted as a concern for Western automotive organizations seeking to remain competitive globally, and it has been suggested that this can be supported through the codification of tacit knowledge (Machacek and Hess, 2019). This research provides a more nuanced understanding of the forms of tacit knowledge requested by an automotive manufacturer of the employees in the PDD and explores how tacit knowledge is used in the PDD to support new product development.

Theoretical Background

Automotive Product Development

Managing new product development is a challenging and complex process (Goffin and Koners, 2011), which is required to enable companies to keep a competitive edge (Harmsen et al., 2000). Product development is a complex activity, which is dependent on knowledge and learning, with most of the required knowledge being tacit (Goffin and Koners, 2011).

The automotive industry and market are typified by global competition, demanding consumers, a complex business environment, and rapid changes in technology, necessitating car manufacturers to develop new products with increasing speed through highly effective and efficient new product development processes (Canonico et al., 2020). Shortened product development cycle times and increasing product quality levels remain crucial differentiating factors for the success of automotive organizations (Tuli and Shankar, 2015). It has been suggested that poor product development processes and coordination in the automotive industry lead not only to delays, increased costs, and a lack of competitive products but also poor-quality products and potential product recalls (Zheng et al., 2020).

Product development within the automotive industry is a cross-functional endeavor that brings together design, marketing, manufacturing, and other functions (Silva and Kaminski, 2017). This requires collaboration across the organization to share information and documents such as project plans, technical drawings, cost projections, documentation, and manufacturing and tooling projections (Ferreira et al., 2017). To support this, many automotive manufacturers have moved their product development away from hierarchically controlled structures to be more flexible to support collaborative relationships (Townsend et al., 2017). Ferreira et al. (2017) highlighted the importance of effective communication within the automotive product development process, as it is essential to connect interdisciplinary teams and stakeholders to ensure reporting of updated documents, problems, and other relevant issues in real-time, as this both saves time and improves the decision-making process. The development of trust within teams and organizations is important in supporting coordination and knowledge sharing in automotive product development (Zheng et al., 2020). Previous experience can also be valuable to support the product development process by considering past solutions to problems (Ferreira et al., 2017).

Managing Knowledge

Knowledge is a well-known and widely used term (Sparrow, 1998) that "evolves when information is combined with experience, context, interpretation, and reflection" (Davenport et al., 1998, p. 43). Marakas (1999) argues that knowledge is the result of organizing ideas, rules, and procedures. Knowledge can be delineated into tacit and explicit knowledge (Nonaka and von Krogh, 2009). Explicit knowledge can be easily verbalized, codified in written form, and stored in documents or databases, while tacit knowledge is personal knowledge embedded in personal experience, context-related, based on awareness, and involving personal factors such as beliefs, perspectives, instincts, and values (Polanyi,1958; 1966).

Seidler-de Alwis and Hartmann (2008) state that tacit knowledge is rooted in actions, procedures, commitments, and emotions, and thus hard to codify. Gascoigne (2013) states that tacit knowledge is context-dependent, conceptually structured, untellable, and practical. Gourlay (2004) argues that tacit knowledge can become explicit knowledge and vice versa. Nonaka and Konno (1998) highlight that tacit knowledge is deeply rooted in an individual's actions and emotions and difficult to express. Saint-Onge (1996) emphasized that tacit

knowledge contains beliefs, values, perspectives, and intuition formed from experience. Fleck (2014) describes tacit knowledge as a subtle level of understanding, recognition, and perception. Sternberg et al. (2000) argue that tacit knowledge is generated with little environmental support and is practically useful.

Quinn et al. (1996) contended that an employee's personal knowledge within an organization contributes to the intellectual capital of that organization. Thus, organizational knowledge is the sum of knowledge possessed by the organization's employees. Organizational knowledge comprises explicit knowledge stored in documents and databases and tacit knowledge embedded in the employees' minds (Guzman and Wilson, 2005). Employees leaving an organization take their tacit knowledge with them (Polanyi, 1958). Thus, organizations need to counteract knowledge loss through successful knowledge management practices, including knowledge retention (Levy, 2011).

Extricating tacit knowledge from its possessor is a key challenge in tacit knowledge research (Nonaka and Takeuchi, 1995; Seidler-de Alwis and Hartmann, 2008). Haldin-Herrgard (2004, p. 14) addresses the difficulties of characterizing tacit knowledge, "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." This provides the possibility of further research by breaking down mental barriers to investigating tacit knowledge (Haldin-Herrgard, 2004). It is possible to find many examples of epitomes of tacit knowledge in the workplace (Haldin-Herrgard, 2000). Whilst tacit knowledge is difficult to articulate, epitomes of tacit knowledge can provide high visibility to tacit knowledge and allow it to be identified (MacAdam et al., 2007).

The role of tacit knowledge

Nelson and Winter (1982) interpreted the role of tacit knowledge held by individual actors in an organization contributing to the understanding of organizational routines performance. Nonaka and Takeuchi (1995) indicate that tacit knowledge is a crucial strategic resource and the most sustainable foundation of competitiveness for an enterprise. It is the source of the entirety of knowledge, performance, and innovative ideas in an organization (Nonaka, 1991; Sternberg et al., 1995). The increasing wealth of tacit knowledge to solve problems and

achieve goals generates a competitive advantage (Jafari et al., 2013). Baumard (1999) contends that tacit knowledge is often crucial for business success in times of uncertainty, rapid change, and turbulence. Tacit knowledge facilitates the ability to cope with new situations and to adapt quickly to new circumstances within changing conditions, putting the 'know-what' into practice (Sternberg et al., 1999; Brown and Duguid, 1998). Haldin-Herrgard (2003) argues it promotes high-quality standards and a competitive advantage, which Seidler-de Alwis and Hartmann (2008) found lies in its nature as a source of opportunities for discovery, innovation, and creativity.

Tacit knowledge plays a key role in business success as an essential element for a competent, efficient, and sustainable performance (Baumard, 1999; Gore and Gore, 1999; Jafari et al., 2013); a leading ability in decision making processes and changing conditions (Brown and Duguid, 1998; Gertler, 2003); and a strategic competitive advantage for an organization (Haldin-Herrgard, 2003). Tacit knowledge is essential for performance improvements and efficiency gains in both technology implementation (Edmondson et al., 2003) and manufacturing processes (Nakano et al., 2013). Furthermore, Gertler (2003) asserts that tacit knowledge within an organization positively impacts the organization's innovativeness and its product and process quality. Chen and Mohamed (2010) link tacit knowledge management with an organization's achievement of objectives. Spender (1996) refers to the loss of an organization´s tacit knowledge as a precursor to a strategic crisis.

Tacit knowledge has been highlighted as essential within the automotive industry for Western manufacturers to remain competitive, particularly against Chinese automotive manufacturers who are developing their knowledge and expertise base (Machacek and Hess, 2019). Previous work includes Nonaka and Takeuchi's (1995) organizational knowledge creation theory, which is based on the Japanese automotive sector and argues that organizational knowledge comes from continuous interaction between tacit and explicit knowledge via socialization, combination, internalization, and externalization. Saad et al. (2003) found crucial knowledge (which includes tacit knowledge) improves corporate memory in a design project in the automotive sector. Dyer and Nobeoka´s (2000) study explained the productivity advantages of Toyota and its suppliers by examining Toyota´s knowledge-sharing ability, including tacit knowledge, within their network.

Studies on tacit knowledge frequently focus on small and medium-sized enterprises (SMEs). Sumbal et al. (2017) highlighted the need for research into the identification of tacit knowledge in large organizations to enable and support knowledge retention within these organizations. Knowledge loss in German organizations due to greater employee turnover poses a risk for efficient organizational performance.

Tacit knowledge has thus been found to be crucial to an organization's success while being argued to be underresearched, particularly in large firms. This research contributes by answering calls for research that brings tacit knowledge to the forefront and examines the ways that tacit knowledge is used in context-specific processes and activities (Hadjimichael and Tsoukas, 2019), and to support organizational knowledge retention by identifying tacit knowledge in large organizations (Sumbal et al., 2017). It provides new insights into the use of tacit knowledge in the PDD of an automotive manufacturer and provides a greater understanding of the frequently-used forms of tacit knowledge through the use of the Haldin-Herrgard (2003) typology of epitomes of tacit knowledge. Epitomes of tacit knowledge embody a vocabulary to articulate and understand the abstraction of the tacit dimension of knowledge, which identifies the different forms of tacit knowledge. Therefore, the epitomes of tacit knowledge can be used as building blocks to identify the forms of tacit knowledge, spoken and written in vocabulary. The next section provides further details of the methodology adopted for this study.

Methodology

The methodology involved two distinct stages. The first quantitative stage quantifies and determines the most commonly requested forms of tacit knowledge through the identification of epitomes of tacit knowledge (Haldin-Herrgard, 2003) in the job role descriptions within the PDD of a multinational car manufacturer based in Germany. The PDD has 4,215 employees. The average age of employees in the PDD is 45 years, while workers older than 50 make up to 37 percent of the department. The workers rely on their personal knowledge more than on the knowledge provided by the organization, which implies that these workers predominantly use tacit knowledge (El-Farr, 2009) that is 'embrained' and

'encultured' (Blackler, 1995). In line with many firms, the organization's knowledge loss potential is due largely to age-based attrition.

Building on the results from the first stage, the second qualitative stage of the research explores how and why the most frequently requested forms of tacit knowledge are commonly used by knowledge workers in this context. Employing a sequential mixed-methods approach supports the research to first identify the most requested forms of tacit knowledge and then explore why and how the most frequently requested forms of tacit knowledge are used in practice. The following subsections explain the two stages of data collection analysis in further detail.

Stage One - Identifying the most frequently requested forms of tacit knowledge

To identify the most commonly requested forms of tacit knowledge and to overcome the challenge of eliciting tacit knowledge (Gore and Gore, 1999; Ambrosini and Bowman, 2001), the research applied Haldin-Herrgard's (2003) framework to screen internal job role descriptions contained within job adverts in the PDD for the tacit knowledge epitomes. Haldin-Herrgard (2003) identified and validated 92 epitomes of tacit knowledge that can identify different forms of tacit knowledge. These epitomes are vocabulary used to refer to tacit knowledge, thus allowing tacit knowledge to be identified in a written and verbal form. These epitomes of tacit knowledge are concepts that facilitate the verbalization of the use of tacit knowledge in any context (Haldin-Herrgard, 2003). This research screened internal job role descriptions for the use of these epitomes to identify the potential requirement of tacit knowledge across a range of positions in the PDD of the organization. Epitomes of tacit knowledge represent, in this context, a possibility to decode tacit knowledge from existing organizational data and make it available to the researchers. This first stage of the research sought to determine the forms of tacit knowledge requested in the job descriptions, rather than the individual epitomes of knowledge within them. This is because job descriptions often lack specificity and nuance and are focused on objectivity, resulting in a lack of subjective criteria being present. Also, the epitomes of tacit knowledge frequently overlap and were not designed to be mutually exclusive. The second stage builds on the identification of the general forms of tacit knowledge requested to elicit more specifically the ways in which the forms of tacit knowledge are used and the 'how' and why' this is used in practice.

The job role documents represent a measure of the requirements of jobs, as they are created by senior supervisors and are reviewed by the human resources department and the department of the working council. This review process is designed to ensure the quality of all internal job roles and consolidates the specialist experience of the job requirements of the three parties. Furthermore, internal job role descriptions react quickly to changes in business and market requirements and often involve lessons learned by senior leaders. Internal job roles always display the latest identified standard of required skills, experiences, and knowledge that an employee must possess to perform successfully in the current position. This ensures that analyzing internal job role information data provides up-to-date information. Previous research has highlighted the value and potential of using job role descriptions and job advertisements as a source of data (Todd et al., 1995). Todd et al. (1995) highlighted that there is no real benefit for an organization to consciously misrepresent the required skills for a position within a job description because the final decision of whether a candidate suits a position is always made in a personal interview. Over representing skills in a job description will only make the possible candidate more sensitive to the expectation of the organization. Potential limitations in this research are further reduced by the fact that this research used only internal job role descriptions, which are only used for internal purposes, and the job role descriptions are monitored by three different stakeholders. Plus, the job descriptions were not developed for or as part of this research, thus increasing their reliability and validity. These factors help to support the job role descriptions as being an effective measure of what is being requested in the roles and to help draw a picture of the tacit knowledge the organization perceives as being required and essential by the knowledge workers in their roles in the PDD.

A total of 362 internal job role descriptions for workers in the PDD were obtained across the calendar years 2015-2017. Non-knowledge workers were removed from this total to provide a final population of 318 job descriptions. All positions required a bachelor's degree as the minimum educational requirement. The 318 internal job descriptions were divided over four salary groups that were related to the educational background and characteristics an employee needed to perform in these roles. The different salary groups represented different levels of experience, and the same PDD job titles existed across the salary groups. All 318 internal job role descriptions were given an identifying code, and a sample of 84 was chosen for analysis using a process of stratified random sampling. The sample was stratified across

the four salary levels so that an equal number of job role descriptions were taken from each level. This provided 21 job role descriptions from each salary level and represented a sample size of 26% of the total population.

Data Analysis - Manifest content analysis of Internal Role Descriptions

A process of manifest content analysis was applied to the job role descriptions to determine the most frequently requested forms of tacit knowledge by reviewing the appearance of epitomes of tacit knowledge. Content analysis is a systematic and replicable research method to study documents, texts, pictures, and videos based on explicit rules of coding to analyze patterns in the data, enabling a researcher to answer research questions (Krippendorff, 2013). 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 mixed methods research (Harris, 2001). Manifest content analysis involves analyzing text for the appearance of predetermined words to identify and quantify the frequency of their appearance (Kondracki et al., 2002). Performing content analysis on secondary data in the form of internal job role descriptions is unobtrusive and helps to reduce potential subjectivism (Krippendorff, 2013). Haldin-Herrgard's (2003) epitomes of tacit knowledge provided the logic for the content analysis coding in this research. To determine the forms of tacit knowledge requested, the internal job descriptions were analyzed for the appearance of the 92 epitomes of tacit knowledge. The epitomes were then categorized into groups (or forms) to determine the most frequently requested forms of tacit knowledge.

The job role descriptions were analyzed independently by two researchers using the same coding framework to increase the validity and reliability of the analysis and demonstrate reproducibility. The agreement level between the results from both coders was 98%. Applying Cohen´s kappa coefficient, the level of agreement can be rated as "almost perfect" (Landis and Koch, 1977, p. 165), suggesting strong reproducibility, validity, and reliability.

Stage Two – Exploring the usage of tacit knowledge

Following on from the first stage of the research and the identification of the most frequently requested forms of tacit knowledge, the second stage explored 'how' and 'why' the most requested forms of tacit knowledge are used in practice by knowledge workers in the PDD of a multinational automotive company. To further explore the use of tacit knowledge, which is

personal knowledge, it was necessary to interact with the possessors (Ambrosini and Bowman, 2001). The literature on tacit knowledge research shows that interviews are commonly used to elicit tacit knowledge (Haldin-Herrgard, 2003; Jones, 2005). The second stage of the data gathering was thus a qualitative approach to enable the research to build on the results from the content analysis. To narrow the themes to be explored, semi-structured interviews were adopted. This allowed the interviews to focus on questions related to the use of the forms of tacit knowledge that had been identified as the most frequently requested by the organization within the first stage of the research. The use of interviews is identified as an appropriate method to build on the identification of the most frequently requested forms of tacit knowledge, to access the hidden world of the 'why' and 'how' it is required in automotive product development. By adopting semi-structured interviews, the interviewer was able to narrow the field of exploration to the use of tacit knowledge that had emerged as being most frequently requested by the organization in the first stage, whilst allowing probing questions to achieve a deeper level of understanding and allowing the understanding of the context (Denzin and Lincoln, 2008).

Twenty-two knowledge workers from the PDD were interviewed from the salary group that demonstrated the highest and most frequent use of tacit knowledge. This decision was made as extending the data collection to other salary groups would distract the focus from the knowledge workers linked to the highest use of tacit knowledge. All the interviewees had a minimum of three years' work experience in their role. Saturation of data occurred after sixteen interviews, and no new codes were generated from the last six interviews, a circumstance that implies that enough data has been collected to ensure a representative range of experience within the dataset that allows replication of the study (O'Reilly and Parker, 2013).

Data Analysis - Thematic analysis of interview data

The interview transcripts were thematically analyzed to identify themes and patterns as to how and why the most frequently requested forms of tacit knowledge are used in practice. The thematic analysis was conducted using an inductive bottom-up approach. This was appropriate as tacit knowledge has not been previously researched in this context, so there was not a top-down framework that could be applied to this research. 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. The data was first coded to draw themes as to how tacit knowledge in the form of skills and experience was used in the interviewee's roles, and then additional codes and sub-themes were developed to explain 'why' and 'how' tacit knowledge was used in this specific way.

To support the rigor of the process, the written transcripts were checked against the recordings (Braun and Clarke, 2006), and a research member checking process was undertaken whereby the transcripts and key points within them were shared and discussed with the interviewees to check for interpretive validity (Birt et al., 2016). The results drawn from the transcripts were reviewed by both a researcher involved within the organization being researched and an external researcher who acted as a peer 'de-briefer' to support the interpretation beyond the researcher and the validity of the findings (Creswell 2014). This supported the benefits and advantages of being an inside researcher whilst providing external authentication (Lincoln and Guba, 1985).

Results and Discussion

Frequently Requested Tacit Knowledge in the PDD

The quantitative content analysis identified the forms of tacit knowledge most frequently requested by the organization in the PDD at the four different salary levels. The total number of epitomes used in the job descriptions across all salary groups and years was 614. The data demonstrated that from the ninety-two epitomes identified by Haldin-Herrgard (2003), ten forms (or groups) of tacit knowledge were requested in the eighty-four job descriptions sampled. The forms of tacit knowledge identified in the job descriptions are presented in table one.

Employees in salary group 3 were highlighted as the employees who were required to use tacit knowledge most frequently. The average number of epitomes used in each job role description for workers in salary group 3 was 9.6 epitomes. Employees in salary group 3 have a high level of expertise in specific fields of the development process and are responsible for generating knowledge to support other colleagues by sharing their knowledge, advising colleagues by sharing their expertise, and by identifying efficiency opportunities to improve business. In general, it can be argued that for this type of knowledge worker, the level of

autonomy, expertise, and specialization is high. Table one shows the range and forms of tacit knowledge identified in the job descriptions.

Table 1: Manifest content analysis results demonstrating the forms of tacit knowledge requested across salary groups

	Forms of Tacit Knowledge Identified										
Salary Groups	Knowledge Base	Experience	Expertise	Ability	Skills	Creativity	Talent	Techniques	Capacity	Understanding	Total
1 (13)	1	13	0	26	56	1	1	1	1	8	108
2 (14)	0	52	0	27	74	5	2	5	3	1	169
3 (AT)	0	46	2	23	98	2	0	9	12	11	203
4 (LL6)	0	58	1	29	36	0	0	0	0	10	134
Total	1	169	3	105	264	8	3	15	16	30	614
Percent	0.2	27.5	0.05	17.1	43.0	1.3	0.5	2.4	2.6	4.9	100

The automotive organization most frequently requests tacit knowledge in the form of skills and experience across knowledge workers in the PDD. These two forms represented 70.5% of all tacit knowledge requested in the job descriptions. For salary group 3, tacit knowledge in the form of skills accounted for 48.2% of the tacit knowledge identified in the job descriptions, whilst experience accounted for 22.7%. These two forms of tacit knowledge together accounted for 71% of all tacit knowledge requested in the job descriptions within salary group 3. This result shows some similarities to the results of the study conducted by Haldin-Herrgard (2003), in which epitomes of these types were among the most frequently found. Tacit knowledge in these forms seems to have a central role in organizations, although the meaning behind these forms might be different in each context. Further exploring skills and experience will help the understanding of how tacit knowledge in these forms is applied by knowledge workers in the PDD of this multinational manufacturer to achieve their purposes.

How and Why Tacit Knowledge Underpinning Skills and Experience are used in Practice

This stage focused on the use and implementation of tacit knowledge in the form of skills and experience, as these were found to account for 70.5% of the tacit knowledge requested by the organization in the PDD job descriptions. From the qualitative data analysis, it was identified that tacit knowledge skills were utilized in the form of tacit knowledge-based socially-focused skills. Whilst experience tacit knowledge stemmed from personally obtained experience. The former was supported by four subthemes and the latter by two subthemes. These themes and subthemes will now be presented and discussed using supporting quotes.

The use of tacit knowledge-based socially-focused skills to facilitate development work

A frequently occurring pattern in the data demonstrated that interviewees applied tacit knowledge in the form of skills through the utilization of socially focused skills. The use of socially focused skills was central to the roles they played in the organization to facilitate development work. Indeed, effective communication has been identified as being essential in the product development process as it helps to connect interdisciplinary teams to both save time and improve the decision-making process (Ferreira et al., 2017). Working together, building up teams, or developing and using networks can be traced back to the use of tacit knowledge-based socially-focused skills, a circumstance that is well recognized by the knowledge workers in this organization. This importance of tacit knowledge-based socially-focused skills is underpinned by Insch et al. (2008), who argued that an understanding of how to act with others describes the social dimension of tacit knowledge. Puusa and Eerikäinen (2010) 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). Because the creation of innovation is seen as a core component of the development work in this organization, the use of tacit knowledge in the form of social skills builds an essential element of interaction in this organization. By applying tacit knowledge-based socially-focused skills, the knowledge workers make things work by bringing people together and aligning them towards a common goal; by enabling people to work together as a team; by developing and using networks; and by acting as a required resource to support the development and integration in product development. The four subthemes will now be unpacked.

The importance of tacit knowledge-based socially-focused skills in making things work

A consistent subtheme within the data was that tacit knowledge-based socially-focused skills were required to make things work. Interviewees 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 interviewee is aware that only a specific way of communicating or interacting with people will end in the result that people can be brought together. Interviewees regularly referred to interacting with people, creating trust, convincing people, bringing people together, and aligning people. These verbalized activities are located in social activities and highlight the use of tacit knowledge-based socially-focused skills. Such processes were highlighted by comments such as:

> "I couldn't have done that without skills like talking to people, bringing people together, and explaining what we're doing and bringing all these things together to get it to work. If I were to simply follow a procedure, like just write a work request, then wait until they get back to me so that I can finish my work, it would have taken ages."
>
> "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 interviews highlighted that a variety of activities are supported, triggered, or progressed by the use of tacit knowledge-based socially-focused skills, which is important to ensure that things get done. Such tacit knowledge is used to make things work by bringing people together, aligning people on a common goal, and making people perform, and the application of tacit knowledge-based socially-focused skills supports this.

Tacit knowledge-based socially-focused skills as a key for working together and building teams

The importance of tacit knowledge-based socially-focused skills when working in a team was recognized by the majority of the interviewees as important in achieving product development goals and outputs. It was highlighted that a single person could not achieve the required outputs, and therefore, team goals need to be set that are based on experience and knowledge from all members. Interacting with people, listening to people, and being open with other people are the main attributes in this form of working together. Interview

participants highlighted that being part of a team and working in a team requires the use of tacit knowledge-based socially-focused skills. Comments which demonstrated this included:

> "If you don't have good social skills, you won't get the team working together or won't get help from the team. You will perhaps not get the information which is required to get the job done".
>
> "We need to establish good soft skills to get all the people on board and to communicate, give them direction, but also work with them together, and it's a big team."

It was also highlighted that tacit knowledge-based socially-focused skills were sometimes required to harmonize teams and team working. This was explained by comments such as:

> "You can come to a situation where you need to take directions when you're in a difficult position. But that's all in the social part, like talking to people, bringing people together, managing conflicts when they're not harmoniously working as a team."

Due to the complexity of product development in the automotive industry, the need for knowledge and experience is essential, and the variety of the knowledge and experience that is required cannot be possessed by a single person. Therefore, it was recognized by the interviewees that working in a team or being part of a team is essential, and this was frequently linked back to the use of tacit knowledge-based socially-focused skills. For this to be successful, it was highlighted that these skills were essential to promote team cohesion and facilitate the work and outputs required.

The use of tacit knowledge-based socially-focused skills to establish networking

Networking with other employees across the organization was highlighted as important to compensate for lack of expertise and knowledge across the whole organization, which would not be possible given the scale of the organization. The value and importance of networking was demonstrated by comments such as:

> "It's through networking that I gained most of my experience. When I started working in my job seven years ago, I didn't know much about cars, only the very general things. I was not educated in the field of automotive or vehicle engineering. That's how I learned a lot of the crucial technical expertise".

Interviewees regularly linked the importance of tacit knowledge-based socially-focused skills with networking. This was highlighted by comments including:

> "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 by working a lot on 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".
>
> "Maybe we had some beer together before we know each other for many years and things like that, sometimes, outside the work environment. Networks and being open-minded helps to get everybody back to this common thinking that we want to work together".

The interviews highlighted that networking is important and that building and using networks across the organization seem to be strongly related to the use of tacit knowledge-based socially-focused skills, which is applied to build up and use networks effectively to compensate for lack of expertise or to increase efficiency in interacting with people.

Tacit knowledge-based socially-focused skills recognized as a required resource in product development

Interviewees identified tacit knowledge-based socially-focused skills as the most important skill in their position. Whilst the need for technical skills was mentioned, it was not justified to the same extent. This can possibly be explained by the circumstance that within product development, a central challenge is getting people working together, aligning individual goals, and convincing people to support the development and integration of new outputs. These requirements were presented in the following way:

> "Without the social network and without social skills, I wouldn´t be able to work very well."
>
> "I believe social skills are very important. As I said, a big part of my work is communication, and in the end, where you see the result, you see that this is a product of many different sub-projects and sub-parts, which all come together in one result. One result is not possible without these millions of small pieces."

> "To achieve the 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 is read from papers. It just wouldn't work."

The interviewees had a common perception that tacit knowledge-based socially-focused skills are an essential element in their job role, which was required in a variety of activities in the organization. The activities described in the subthemes above make things work and are essential to work in a team or develop and use networks. It is the sum of these activities, as part of the performance in the PDD, that facilitates development work in this organization.
The theme and sub-themes relating to the use of tacit knowledge in the form of experience will now be presented.

<u>The use of tacit knowledge from personally obtained experience to enhance development work</u>

Tacit knowledge in the form of experience is applied through the use of personally obtained experience. Patterns in the data highlighted that the personally obtained experience of the participants was important in enabling participants to work more efficiently. Previous experience has been highlighted as playing a supporting role in the product development process through the consideration of effective solutions to past challenges and problems (Ferreira et al., 2017). Through personal experience, participants increased their self-confidence or developed a feeling for specific situations. Personal experience is used by the participants to handle specific situations in their daily business and through this enhance development work.

Experience from different sections within the organization and from different situations, especially in the field of social interaction, is mentally processed by the knowledge workers in this organization. '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 is internalized into the individual's tacit knowledge base and become valuable assets for the organization (Nonaka and Takeuchi, 1995). The ability of the knowledge workers to organize the obtained experiences in the way that these experiences can be used to generate skills and abilities for similar situations in other contexts relates to the use of tacit knowledge in the form of 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 research. The two subthemes which underpin the application of experience will now be unpacked.

The use of tacit knowledge from personally obtained experience as a pacemaker for increased efficiency

Most of the interviewees stated that the personal experience they have obtained has helped them become more efficient in their roles. This was demonstrated by statements such as:

> "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."
>
> "My experience helps me to make the right decision at the right time."

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 "all-rounder" who has a variety of experiences can generate a broader understanding, and this works even more efficiently. One interviewee stated:

> "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."

Another strong pattern that emerged across the data set is related to the importance of obtaining personal experience in the field of social skills used to increase efficiency. This is highlighted by statements such as:

> "You learn by experience who you're talking to, and you adapt your communication style to get at least an answer, and best case help, or the solution you need from this person."
>
> "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 to the interviewees. The process of developing or improving social skills through experiences is a mental process that 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 subtheme captured the use of tacit knowledge in the form of personal experience by describing mental processes deeply ingrained in the participants. Personal knowledge was developed from personal experiences the participant obtained with different departments or activities. This new personal knowledge is based on the use of tacit knowledge in the form of experience and is used by the participants to increase efficiency in this organization.

Processing personally obtained experience to develop self-confidence 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 their roles. This was highlighted by comments such as:

> "Based on my experience, I gain more confidence, and what I can observe is that I also behave differently within the time, regarding everything like meetings and presentation skills. Because you're gaining a routine, and you don't get stressed so quickly."
>
> "The experience gives you the confidence to do the job, to be patient and calm in critical situations, and not to get nervous and not to exaggerate. Also, (you learn) not to influence or impress people in a negative way."

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 is the result of using tacit knowledge in the form of experience by the participants. Some participants developed a further use of tacit knowledge in the form of experience beyond the feeling of confidence. The feeling the participants referred to seems to be a feeling which is related to a validity check in their business. Since the participants were able to link experience to feelings, 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 indicate that tacit knowledge in the form of experience enables the participants to develop a feeling for the correctness of data or to develop a sense of potential upcoming issues.

The interviewees highlighted that they were increasing their performance and the performance of the organization by developing their ability to detect potential issues through their previous experience. The process of using personal experience to generate new knowledge – knowledge that helps the participants to increase their effectiveness and the efficiency of the organization, or that helps the participants develop a 'feeling' – is deeply mentally ingrained in the participants. The fact that the majority of the interviewees 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 organization.

Conclusion

This research identified the forms of tacit knowledge frequently requested of knowledge workers in the PDD by a multinational car manufacturer and then explored how and why this tacit knowledge was used in practice. This contributed by addressing calls to investigate the processes and activities that tacit knowledge is related to in specific contexts (Hadjimichael and Tsoukas, 2019). This paper extended research into the context of a large multinational car manufacturer where there is currently a dearth of research. The research focused on the PDD, as it has been shown that tacit knowledge is essential for knowledge creation in this area (Canonico et al., 2020).

This research developed new knowledge by eliciting what tacit knowledge is requested in the PDD of an automotive organization by applying Haldin-Herrgard's (2003) framework and then explored how employees use and apply forms of tacit knowledge in their roles. The research identified that the forms of tacit knowledge most frequently requested of employees in the PDD was in the form of skills and experience. The thematic analysis elicited the actual usage behind the frequently requested forms of tacit knowledge. The analysis revealed that tacit knowledge in the form of skills is associated with the use of tacit knowledge-based socially-

focused skills by knowledge workers, who use them to interact with, motivate, and align members of the organization to work cohesively as teams to get results, as well as developing networks. Tacit knowledge in the form of experience is applied through the use of personally obtained experience to support efficiency improvements and problem avoidance and is related to quality and efficiency topics of internal processes, the identification of potentially upcoming process issues, and the judgment of data in terms of validity.

Practical and Managerial Implications

This research offers the first clear understanding of how tacit knowledge in the form of skills and experience is used and applied by knowledge workers to organizational activities in the product development department in the automotive sector and how these activities impact new product development. To compete with lower-cost competitors, organizations need to retain their tacit knowledge base, which supports their development of new products. The importance of identifying and codifying knowledge has previously been highlighted in the literature to ensure that western automotive organizations remain competitive in an increasingly competitive global market (Machacek and Hess, 2019).

The research contributes by providing a more nuanced understanding of the tacit knowledge required and how it is used to support new product development. Tacit knowledge-based socially-focused skills are used in the product development process to facilitate innovation and product development. Workers are brought together, focused towards a common target, motivated, and convinced to achieve a common goal through the usage and application of tacit knowledge-based socially-focused skills. Things get done, networks are established and used to support this. Tacit knowledge from personally obtained experience is used to increase efficiency in a multitude of activities. Using the application of tacit knowledge in the form of personally obtained experience, knowledge workers can self-navigate and successfully perform in areas or fields that are new or infrequently approached. Individual and organizational performance is increased, and the development work is enhanced. The findings in this research indicate that tacit knowledge-based socially-focused skills and tacit knowledge from personally obtained experience are particularly important for the efficient and effective operation of the PDD within the organization. Therefore, this should be reflected in future job descriptions, recruitment, and training. An organization can prioritize the application of knowledge protection actions or can launch training, workshops, and processes to retain and

improve the diffusion throughout the organization of the identified tacit knowledge frequently used in the organization. To support the development of tacit knowledge-based socially-focused skills, the organization can encourage the development of social interaction and engagement between peers. Reflection can be encouraged and supported to help workers learn from experience through experiential learning and promote the development of tacit knowledge from personally obtained experience (Bell and Pham, 2020). Dabic and Kiessling (2019) have highlighted that effective knowledge management practices should enable employees to have the training and acumen to identify important knowledge. The risk of possible knowledge loss due to employee turnover on an organization's performance can be assessed through the classification of the positions in an organization according to the amount of tacit knowledge required to perform these positions. Minimizing the impact of knowledge loss in employee turnover in those areas with high levels of tacit knowledge is seen as critical to organizational performance.

Limitations and Future Research

The primary limitation of this research is related to the generalizability of the results. Because tacit knowledge is context related; the results of this research might not be relevant for knowledge workers of other organizations in the field of product development (Nonaka and Takeuchi, 1995; Gascoigne, 2013). However, although tacit knowledge research is context-related, other organizations could consider these forms of tacit knowledge to increase their organizational performance and improve their knowledge management and product development activities. The results of this research could potentially be transferable to other product development settings where knowledge workers perform non-routine tasks requiring thought and decision making (Choi and Varney, 1995). The findings of this research could be relevant to other industries which rely on ongoing product development using teams and could be of significance for other engineering and manufacturing contexts. Future research may extend this research by selecting knowledge workers from other organizations and other sectors and comparing their results with the results of this research to add another piece to the puzzle of understanding the use of tacit knowledge in organizations. This research has shown that job descriptions are an important source of data in an organization. Future research may concentrate on the development of an approach and a process to create job descriptions based on the use of epitomes of tacit knowledge. Future research could explore

whether discrepancies exist between the tacit knowledge requested by organizations and that used and applied by employees, as this would highlight areas where organizations had a deficiency in the awareness of the tacit knowledge required in particular roles.

References

Ambrosini, V. and Bowman, C. (2001), "Tacit knowledge: Some suggestions for operationalization", *Journal of Management Studies*, Vol. 38 No. 6, pp.811–829.

Baumard, P. (1999), *Tacit knowledge in Organizations*, Sage Publications, London.

Bell, R. and Pham, T.T. (2020), "Modelling the knowledge transfer process between founder and successor in Vietnamese family businesses succession", *Journal of Family Business Management*. doi.10.1108/JFBM-03-2020-0024.

Birt, L., Scott, S., Cavers, D., Campbell, C. and Walter, F. (2016), "Member checking: A tool to enhance trustworthiness or merely a nod to validation?", *Qualitative Health Research*, Vol. 26 No. 13, pp.1802–1811.

Blackler, F. (1995), "Knowledge, knowledge work and organizations: An overview and interpretation", *Organization Studies*, Vol. 16 No. 6, pp.1021–1046.

Braun, V. and Clarke, V. (2006), "Using thematic analysis in psychology", *Qualitative Research in Psychology*, Vol. 3 No. 2, pp.77–101.

Brown, J.S. and Duguid, P. (1998), "Organizing knowledge", *California Management Review*, Vol. 40 No. 3, pp.90–111.

Bundesagentur für Arbeit (2017) Aktuelle Entwicklungen der Zeitarbeit. Available at: https://statistik.arbeitsagentur.de/Statischer-Content/Arbeitsmarktberichte/Branchen-Berufe/generische-Publikationen/Arbeitsmarkt-Deutschland-Zeitarbeit-Aktuelle-Entwicklung.pdf (Accessed: 30 September 2017).

Canonico, P., De Nito, E., Esposito, V., Pezzillo Iacono, M. and Consiglio, S. (2020), "Knowledge creation in the automotive industry: Analysing obeya-oriented practices using the SECI model", *Journal of Business Research*, Vol. 112, pp.450–457.

Chen, L. and Mohamed, S. (2010), "The strategic importance of tacit knowledge management activities in construction", *Construction Innovation*, Vol. 10 No. 2, pp.138–163.

Choi, T. Y. and Varney, G. H. (1995), "Rethinking knowledge workers: Where have all the workers gone?", *Organization Development Journal*, Vol. 13 No. 2, pp.41–50.

Creswell, J. (2014), *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Sage, Thousand Oaks, CA.

Dabic, M. and Kiessling, T. (2019), "The performance implications of knowledge management and strategic alignment of MNC subsidiaries", *Journal of Knowledge Management*, Vol. 23 No. 8, pp.1477–1501.

Dachverband der Betriebskrankenkassen (2016) Sickness Rate Dachverband BKK 2016. Available at: https://www.iwd.de/artikel/krankenstand-in-deutschland-steigt-456309/. (Accessed: 30 September 2017).

Davenport, T., De Long, D. and Beers, M. (1998), "Successful knowledge management projects", *Sloan Management Review*, Vol. 1, pp.43–57.

De Long, D. and Davenport, T. (2003), "Better practices for retaining organizational knowledge: Lessons from the leading edge", *Employment Relations Today*, Vol. 30 No. 3, pp.51–63.

Denzin, N. and Lincoln, Y. (2008), *Collecting and Interpreting Qualitative Materials*, Sage, Thousand Oaks, CA.

Dyer, J.H. and Nobeoka, K. (2000), "Creating and managing a high-performance knowledge-sharing network: The Toyota Case", *Strategic Management Journal*, Vol. 21 No. 3, pp.345–367.

Edmondson, A., Winslow, A., Bohmer, R. and Pisano, G. (2003), "Learning how and learning what: Effects of tacit and codified knowledge on performance improvement following technology adoption", *Decision Sciences*, Vol. 34 Vol. 2, pp.197-224.

El-Farr, H.K. (2009), "Knowledge work and workers: A critical literature review", Leeds University Business School, Working Paper Series, 1(1), pp.1–15. ISSN 1743-6796.

Ferreira, F., Faria, J., Azevedo, A. and Marques, A.L. (2017), "Product lifecycle management in knowledge intensive collaborative environments: An application to automotive industry", *International Journal of Information Management*, Vol. 37 No. 1, pp.1474–1487.

Fleck, J. (2014), "Informal information flow and the nature of expertise in financial services", *International Journal of Technology Management*, Vol. 11 No. 1/2, pp.104–128.

Gascoigne, N. (2013), *Tacit Knowledge*, Acumen Publishing Limited, Durham.

Gertler, M.S. (2003), "Tacit knowledge and the economic geography of context, or the undefinable tacitness of being (there)", *Journal of Economic Geography*, Vol. 3 No. 1, pp.75–99.

Goffin, K. and Koners, U. (2011), "Tacit Knowledge, Lessons Learnt, and New Product Development", *Journal of Product Innovation Management*, Vol. 28 No. 2, pp.300–318.

Gore, C. and Gore, E. (1999), "Knowledge management: The way forward", *Total Quality Management*, Vol. 10 No. 4/5, pp.554–560.

Gourlay, S. (2004), "Knowing as semiosis: Steps towards a reconceptualization of tacit knowledge'', Tsoukas, H. and Mylonopoulos, N. (Ed.), *Organizations as Knowledge Systems: Knowledge, Learning and Dynamic Capabilities*, Palgrave Macmillan, London, pp.86–105.

Guzman, G.A.C. and Wilson, J. (2005), "The "soft" dimension of organizational knowledge transfer", *Journal of Knowledge Management*, Vol. 9 No. 2, pp.59–74.

Hadjimichael, D. and Tsoukas, H. (2019), "Toward a Better Understanding of Tacit Knowledge in Organizations: Taking Stock and Moving Forward", *Academy of Management Annals*, Vol. 13 No. 2, pp.672–703.

Haldin-Herrgard, T. (2000), "Difficulties in diffusion of tacit knowledge in organizations", *Journal of Intellectual Capital*, Vol. 1 No. 4, pp.357–365.

Haldin-Herrgard, T. (2003), "Mapping tacit knowledge with "epitomes"', *Systemes D'Information et Management*, Vol. 8 No. 2, pp.93–111.

Haldin-Herrgard, T. (2004), "Diving under the surface of tacit knowledge", Fifth European Conference on Organizational Knowledge, Learning, and Capabilities, 2-3 April, University of Innsbruck, Austria.

Harmsen, H., Grunert, K.G. and Bove, K. (2000), "Company Competencies as a Network: The Role of Product Development", *Journal of Product Innovation Management*, Vol. 17 No. 3, pp.194–207.

Harris, H. (2001), "Content analysis of secondary data: A study of courage in managerial decision making", *Journal of Business Ethics*, Vol. 34 No. 3/4, pp.191–208.

Insch, G.S., McIntyre, N. and Dawley, D. (2008), "Tacit knowledge: A refinement and empirical test of the academic tacit knowledge scale", *The Journal of Psychology*, Vol. 142 No.6, pp.561–580.

Jafari, M., Akhavan, P. and Nourizadeh, M. (2013), "Classification of human resources based on measurement of tacit knowledge", *Journal of Management Development*, Vol. 32 No. 4, pp.376–403.

Jisr, R.E. and Maamari, B.E. (2017), "Effectuation: Exploring a third dimension to tacit knowledge", *Knowledge and Process Management*, Vol. 24 No. 1, pp.72–78.

Joe, C., Yoong, P. and Patel, K. (2013), "Knowledge loss when older experts leave knowledge-intensive organisations", *Journal of Knowledge Management*, Vol. 17 No. 6, pp.913–927.

Jones, M.C. (2005), "Tacit knowledge sharing during ERP implementation", *Information Resources Management Journal*, Vol. 18 No. 2, pp.1–23.

Kabir, N. (2013), "Tacit knowledge, its codification and technological advancement", *The Electronic Journal of Knowledge Management*, Vol. 11 No. 3, pp.235–243.

Kondracki, N.L., Wellman, N.S. and Amundson, D.R. (2002), "Content analysis: Review of methods and their applications in nutrition education", J*ournal of Nutrition Education and Behavior*, Vol. 34 No. 4, pp.224–230.

Krippendorff, K. (2013), *Content Analysis: An introduction to its methodology*, Sage, Thousand Oaks, CA.

Landis, J.R. and Koch, G.G. (1977), "The measurement of observer agreement for categorical data', *Biometrics*, Vol. 33 No. 1, pp.159.

Leonard, D.A. and Sensiper, S. (1998), "The role of tacit knowledge in group innovation", *California Management Review*, Vol. 40 No. 3, pp.112–132.

Letmathe, P. and Rößler, M. (2019), "Tacit knowledge transfer and spillover learning in ramp-ups", *International Journal of Operations & Production Management*, Vol. 39 No. 9/10, pp.1099–1121.

Levallet, N. and Chan, Y.E. (2019), "Organizational knowledge retention and knowledge loss", *Journal of Knowledge Management*, Vol. 23 No. 1, pp.176–199.

Levy, M. (2011), "Knowledge retention: Minimizing organizational business loss", *Journal of Knowledge Management*, Vol. 15 No. 4, pp.582–600.

Lincoln, Y. and Guba, E. (1985), *Naturalistic Inquiry*, Sage, London.

Machacek, E. and Hess, M. (2019), "Whither 'high-tech' labor? Codification and (de-)skilling in automotive components value chains", *Geoforum*, Vol. 99, pp.287–295.

Marakas, G.M. (1999), *Decision Support Systems in the 21st Century*, Prentice Hall, Jersey City, NJ.

McAdam, R., Mason, B. and McCrory, J. (2007), "Exploring the dichotomies within the tacit knowledge literature: Towards a process of tacit knowing in organizations", *Journal of Knowledge Management*, Vol. 11 No. 2, pp.43–59.

Nakano, D., Muniz, J. and Dias Batista, E. (2013), "Engaging environments: Tacit knowledge sharing on the shop floor", *Journal of Knowledge Management*, Vol. 17 No. 2, pp.290–306

Nelson, R. R. and Winter, S. G. (1982), *An Evolutionary Theory of Economic Change*, Harvard University Press, Cambridge, MA,

Nonaka, I. (1991), "The knowledge creating company", *Harvard Business Review*, Vol. 69, pp.96-104.

Nonaka, I. and Konno, N. (1998), "The concept of "BA" - Building a foundation for knowledge creation", *California Management Review*, 40(3), pp.40-54.

Nonaka, I. and Takeuchi, H. (1995), *The Knowledge-Creating Company: How Japanese companies create the dynamics of innovation*, Oxford University Press, Oxford.

Nonaka, I. and von Krogh, G. (2009), "Tacit knowledge and knowledge conversion: Controversy and advancement in organizational knowledge creation theory", *Organization Science*, Vol. 20 No. 3, pp.635–652.

O'Reilly, M. and Parker, N. (2013), "Unsatisfactory saturation: A critical exploration of the notion of saturated sample sizes in qualitative research", *Qualitative Research*, Vol. 13 No. 2, pp.190–197.

Polanyi, M. (1958), *Personal Knowledge*, Routledge, London.

Polanyi, M. (1966), *The Tacit Dimension*, Doubleday Broadway, Chicago, IL.

Puusa, A. and Eerikäinen, M. (2010), "Is tacit knowledge really tacit?", *Electronic Journal of Knowledge Management*, Vol. 8 No. 3, pp.307–318.

Quinn, B., Anderson, P. and Finkelstein, S. (1996), "Intellect: Making the most of the best", *Harvard Business Review*, Vol. 72 No. 2, pp.71–80.

Saad, I., Grundstein, M. and Rosenthal-Sabroux, C. (2003), "Improving the corporate memory by capitalizing on company's crucial knowledge: Case study in automotive company", G*roup Decision and Negotiation*, Vol. 14 No. 2, pp.131–145.

Saint-Onge, H. (1996), "Tacit knowledge the key to the strategic alignment of intellectual capital", *Planning Review*, Vol. 24 No. 2, pp.10–16.

Scarbrough, H. (1999), "Knowledge as work: Conflicts in the management of knowledge workers", *Technology Analysis and Strategic Management*, Vol. 11 No. 1, pp.5–16.

Seidler-de Alwis, R. and Hartmann, E. (2008), "The use of tacit knowledge within innovative companies: Knowledge management in innovative enterprises", *Journal of Knowledge Management*, Vol. 12 No. 1, pp.133–147.

Silva, G.C. and Kaminski, P.C. (2017), "Proposal of framework to managing the automotive product development process", *Cogent Engineering*, Vol. 4 No. 1, p.1317318.

Sparrow, J. (1998), *Knowledge in Organizations: Access to thinking at work*, Sage, London.

Spender, J.C. (1996), "Organizational knowledge, learning and memory: Three concepts in search of a theory", *Journal of Organizational Change Management*, Vol. 9 No. 1, pp.63–78.

Statistik Bundesagentur für Arbeit (2018) Beschäftigte nach Altersgruppen (Zeitreihe Quartalszahlen), Nürnberg.

Sternberg, R., Forsythe, G., Hedlund, J., Horvath, J., Wagner, R., Williams, W., Snook, S. and Grigorenko, E. (2000), *Practical Intelligence in Everyday Life*, Cambridge University Press, Cambridge.

Sternberg, R., Forsythe, G., Hedlund, J., Horvath, Tremble, T., J., Wagner, R., Williams, W., Snook, S., Wagner, R. and Grigorenko, E. (1999), *Tacit Knowledge in the Workplace*, U.S. Army Research Institute for the Behavioural and Social Sciences, Alexandria, VA.

Sternberg, R., Wagner, R., Williams, W. and Horvath, J. (1995), "Testing common sense", *American Psychologist*, Vol. 50 No. 11, pp.912–927.

Sumbal, M., Tsui, E., See-to, E. and Barendrecht, A. (2017), "Knowledge retention and aging workforce in the oil and gas industry: A multi perspective study", J*ournal of Knowledge Management*, Vol. 21 No. 4, pp.907–924.

Todd, P.A., McKeen, J.D. and Gallupe, R.B. (1995), "The evolution of IS job skills: A content analysis of IS job advertisements from 1970 to 1990", *MIS Quarterly*, Vol. 19 No. 1, pp.1–27.

Townsend, J.D., Balestra, S. and Schulze, A. (2017), "Characteristics of project-based alliances: evidence from the automotive industry", *International Journal of Automotive Technology and Management*, Vol. 17 No. 1, pp.8–25.

Tuli, P. and Shankar, R. (2015), "Collaborative and lean new product development approach: a case study in the automotive product design", *International Journal of Production Research*, Vol. 53 No. 8, pp.2457–2471.

Venkitachalam, K. and Busch, P. (2012), "Tacit knowledge: Review and possible research directions", *Journal of Knowledge Management*, Vol. 16 No. 2, pp.357–372.

Zheng, Y., Liu, S., Huang, W. and Jiang, J.J.-Y. (2020), "Inter-organizational cooperation in automotive new product development projects", *Industrial Management & Data Systems*, Vol. 120 No. 1, pp.79–97.