Tacit knowledge in sharing organisational expertise

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Abstract

The value of tacit knowledge has been recognized in organizations in a new level. Tacit knowledge brings value and is an important asset to the organization. With tacit knowledge, we can dig deeper into the issues in organizations and transfer knowledge embedded in people and ICT-systems better. Tacit knowledge is acquired from experience and practice, and embedded in routines. Creation of new knowledge comes from connecting explicit knowledge with tacit knowledge. The biggest problem of knowledge creation is collecting the tacit knowledge of people.

The goal of this research was to discover where tacit knowledge exist, how to collect it and how to integrate it with existing knowledge. This research is a part of the SEED ecosystem project. The research is a literature review, and it is executed by studying literature on tacit knowledge, asset management and maintenance in forest industries. The goal of this report is to find the tools and tricks to find, store, transfer and share tacit knowledge in organizations.

Sharing tacit knowledge is difficult, since it is embedded in people's heads, and sharing and transforming tacit knowledge into explicit is hard. However, studies have shown that employees share tacit knowledge in informal or crises situations better. This knowledge can be transformed to explicit knowledge and connected to previous knowledge with steps introduced in the SECI model. Alongside of transforming tacit knowledge to explicit knowledge tacit knowledge can be found in the companies ICT systems. Mining this data can be done with programming and mathematical equations. During major shutdown situations, the flow of knowledge can be visualized with fault trees and Equivalent Reliability Block Diagrams (RBDs). Sharing tacit knowledge in the forest industry could be improved with mining maintenance systems and interviewing employees. However, even if we do everything right in finding tacit knowledge, there is always knowledge that is hard to uncover.

Preface

The value of tacit knowledge has been recognized in organizations in a new level. Tacit knowledge brings value and is an important asset to the organization. With tacit knowledge, we can dig deeper into the issues in organizations and transfer knowledge embedded in people and ICT-systems better. The term “tacit knowledge” is widely recognized nowadays, but there is not much research or discussion done about the role, that tacit knowledge plays in forest industries, asset management and maintenance functions.

In this report tacit knowledge is mainly discussed from asset management and maintenance point of view. The term tacit knowledge is defined and the role of tacit knowledge in organizations and the benefits it may bring when utilized better are discussed. The goal of this report is to find the tools and tricks to find, store, transfer and share tacit knowledge in organizations.

Writing of this report has been interesting and insightful. Tacit knowledge is an interesting and broad topic, and the importance of tacit knowledge is growing. A lot has been learned while writing this report and my own experiences and knowledge has been developing during this process. I would like to thank all the parties involved in discussion of the research topics and giving me insights and feedback during the whole writing process.

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1. Introduction

The globalization of markets is pushing manufacturing companies to hop to the trend of dispersed value-added chains and cooperative engineering processes. Production planning and IT-landscaping is needed to develop functions in today's global market. Especially IT-solutions have not been utilized enough to allow fast and flexible information integration in the companies. (Anderl & Rezaei, 2007) Digitalized manufacturing information flow should be implemented to facilitate collaborative networking in the field of industry (Bachlaus et al., 2007).

In the forest industry, companies need to make changes in asset management and maintenance to meet the challenges of global competition (Roda & Garetti, 2015). To gain a good position in the field of industry, managing resources, production processes, systems, and sub-systems is required. To meet the company goals, different working areas such as maintenance, logistics, and quality control should be integrated and synchronized. (Al-Najjar & Algabroun, 2017) Engineering Asset Management (EAM) has grown in popularity in the global industry since nearly all kinds of industrial sectors need asset management. When properly done, asset management can make a big difference in an organization's competitiveness on a global scale. (Tse, 2017) However, a multidisciplinary approach with interactions between engineering, finance, accounting, human resources, logistics, and information systems are required to contribute effective asset management (Maré, 2015).

Asset managers and engineers are required to make decisions on how to distribute financial assets between activities, such as repair, renewal, inspection, and obtaining of new tangible or intangible production resources. However, the absence of adequate information on the actual value of the activity usually leads to issues with the decision-making process (Cholette et al., 2015). Since the customer demands for organizations are constantly increasing, the organizations must invest in new technologies for enduring competition, increasing good management of their own expertise. In order to stay in the market, the most important features of companies are their knowledge and expertise on the business processes. (Bossmann et al., 2007)

Humans can apply their senses and experience in a decision-making process, thus gaining knowledge. This type of personal knowledge is called tacit knowledge. If companies can extract and exploit the tacit knowledge they have, it could improve their decision-making processes significantly. (Amadi-Echendu & de Smid, 2015) Knowledge management is gaining momentum as one of the primary elements in many organizations, because of the growing awareness of the value of data. Knowledge as an asset exceeds products and money in importance. Successes and failures of projects and product development are stored in the knowledge that exist in the company employees. The issue that especially the forest industry companies are facing is keeping this knowledge with current and future employees. (Vertommen & Duflou, 2007) Most forest companies are facing the problem of employee aging and with many employees retiring; the fear is that much of the company's knowledge retires with them. Now is the time to collect the tacit knowledge the employees have. A good example here is the Finnish forest industry that is challenged due to the demography and training issues as up to 25% of professionals and experts in the industry will retire in the next few years (Metsäteollisuus, 2016).

Tacit knowledge, however, carries some issues too. Tacit knowledge is embedded in people's practical skills, expertise, and cognitive beliefs and viewpoints, which makes it difficult to collect, codify, and share (Redding et al., 2015). In asset management, the problems with tacit knowledge sharing should be tackled by developing business models and take place in global competition. In manufacturing and asset management, a person working in the field possesses tacit knowledge, which can for example appear as a 'feeling' of machines condition. This tacit knowledge should be used to supplement data and information derived from

the ICT systems of the company, and applied to evaluate the state of the machine. (Amadi-Echendu & de Smid, 2015)

The role of knowledge in organizations should be considered with a new vision. The effective utilization of knowledge has developed into an element of strategic, economic, social, and political importance. Collaborative working and learning boosts for example project success, due to enlarged possibilities to do immediate market research, receiving instant feedback, failing fast and cheap, and exploiting the wisdom of the masses. (Maravilhas & Martins, 2019) Could such methods and tools provide solutions also to the tacit knowledge challenges in the manufacturing industry? How should such tools be further developed and applied?

Nowadays, the importance of knowledge as a resource of business success in organization is widely recognized. Information and knowledge is seen as an indispensable constituent to any organization's resilience and success. Tacit knowledge is accumulated only through practice and experience, and knowledge that is attained over time is challenging to describe to others. (Maravilhas & Martins, 2019)

2. Goal

This literature review is a part of the SEED ecosystem -project, which aims at developing co-operation between the Finnish forest industry and IT-industry and at developing new digitalized solutions that help to improve the competitiveness in the Finnish forest industry. This paper focuses on how to best utilize knowledge embedded in the forest manufacturing organizations. Knowledge is needed to make the best solutions possible. In this paper knowledge and especially tacit knowledge sharing and transferring is researched.

Knowledge can be processed with many different points of view (Kortelainen et al., 2019). However, in this context the more interesting part of knowledge is tacit knowledge. Tacit knowledge is knowledge embedded in people's minds, which makes it hard to transfer and share. In the forest industries and digital solutions, tacit knowledge plays a big role in the effectivity and efficiency of operations and asset management.

The goal of the literature review is to find out how tacit knowledge can be utilized better in asset management in manufacturing companies in the forest industry. The goal is approached by researching issues regarding tacit knowledge. In this literature review, the aim is to discover answers to the following questions: how tacit knowledge can be found, where to find it, how to collect it, and how to integrate it with existing explicit knowledge.

Tacit knowledge is widely researched and many research papers and studies have been executed of the subject. Tacit knowledge in asset management and maintenance, however, is a lesser-studied field. A variety of case studies of tacit knowledge being used for example in the health sector or in the construction industry has been written, but studies about tacit knowledge in the forest industry are more difficult to find. There seem to be recent research in manufacturing industry. Some new studies of maintenance functions and knowledge sharing has been conducted, and studies on knowledge transferring in different scenarios are appearing more.

3. Tacit Knowledge

Knowledge can be divided into tacit and explicit knowledge. Explicit knowledge is acquired from facts, information and education. Explicit knowledge is indicated through metaphors, analogies, models and

concepts. The key for the creation of new knowledge is explicit knowledge. It can be shared, communicated, codified and saved (Maravilhas & Martins, 2019). Tacit knowledge is a bit more difficult to define.

Since knowledge is subjective and exists inside people's heads, it is acquired from experience and related with practice (Nonaka & Takeuchi, 1995). Know-how and knowledge is attained through the whole life, but it is challenging to share (Buckley & Jakovljevic, 2012). Molander (1992) argues that no knowledge is entirely tacit or entirely explicit, but has aspects of both.

Redding et al. (2015) defines tacit knowledge as the understanding and experiences that exist in the individual or entity. They state that tacit knowledge contains two individual features: technical and cognitive elements. The technical element is usually seen in the practical skills and product/process expertise the individual has. Technical elements of tacit knowledge cannot be codified, since they are engaged in the understanding of the tasks. However, the cognitive element of tacit knowledge is evolved from opinions and perspectives the individual has developed, which makes it difficult to codify and distribute too. (Redding et al., 2015)

Bossmann et al. (2007) brings forth another type of knowledge: context or background knowledge. Information arises from understanding data. In other words, a person has to have some prior knowledge in order to attain new knowledge (Maravilhas & Martins, 2019). Understanding data means that the data is associated with previously known facts and other pieces of data (Bossmann et al., 2007; Maravilhas & Martins, 2019).

Cheung and Maropoulos (2007) states that there are four types of knowledge, the first one being 'know-what', which is knowledge about the facts. Second one being 'know-why', which states scientific knowledge and understanding. The third one is 'know-how', which refers to tacit knowledge, which is skills, capabilities, and abilities one has. For example this could be knowledge on how to use a mahcine or apply skills through practice. The fourth and final type of knowledge is 'know-who', which implies where the knowledge is stored. This is the hardest type of knowledge to capture, since it requires deep understanding of the surrounding context and the know-how of people. (Cheung & Maropoulos, 2007)

On an organizational level, tacit knowledge and expertise can be divided into different sublevels: business process know-how, design know-how, manufacturing know-how, organization know-what and organization know-why. Business process know-how focuses on marketing, purchasing, supply chains and costing data. Design know-how defines information and standards on product design. Manufacturing know-how consists of knowledge statements on production processes and machinery. Organization know-what defines empirical knowledge and know-why defines principles of why things happen. (Cheung & Maropoulos, 2007)

Routines are actions where the actor no longer needs to think about the action they are doing, because they have repeated the same action several times. Routinisation begins with following rules, manuals or observing other people. Repetition enables the actor to remember the steps of the action, and therefore the action becomes a routine. (Michael Eraut, 2000) Routinisation is a form of tacit knowledge, where the explicit procedural action is transformed into tacit knowledge through repetition.

On an organizational level, it has been seen, that employees take many of the aspects of their job for granted, thus not describing the tasks very accurately. The employers are very aware of the fact that they have learned to do things of their job subliminally, but they could not define their expertise and knowledge easily. (Michael Eraut, 2000) On other words, the routinized workflow that the employees have honed over a longer period is difficult to share, because routine actions do not require thinking.

It is a common problem to find the access to this tacit knowledge. Some people tell more than others, and some types of knowledge are easier to share than others (Michael Eraut, 2000). Finding the tools to mine the

tacit knowledge of employees is necessary in order to utilize the potential of knowledge in the companies in a more extensive manner.

4. Limitations

The research was carried out by reviewing articles. The scope was limited in finding information about tacit knowledge and the collection and transferring of tacit knowledge in asset management and maintenance. Also manufacturing and forest industry was taken into account. However, most of the information about tacit knowledge sharing was not linked to any particular industry. Full case studies of tacit knowledge in asset management or maintenance could not been found, and paper and pulp industry is not too much studied in this area of expertise. Straight literature about the subject was hard to find, since the literature is mainly from VTT's search engines results.

Limitations on tacit knowledge and articles is the issues on how tacit knowledge is interpreted. Some authors may use tacit knowledge without defining or seeking to define it further, this leads to limitations in the collective usage of the term. Tacit knowledge might refer to uncommunicated knowledge, or the knowledge that cannot be communicated. Tacit knowledge might be treated as an attribute of the knower or as an attribute itself. (Michael Eraut, 2000)

In this research several issues on tacit knowledge sharing in the forest industry was not studied deeply. One interesting topic would be how tacit knowledge is divided in companies, and which employees have specific tacit knowledge. This topic was however difficult to define and there were not too much source material about the topic. Only little research has been done on other scenarios, like major shutdowns, where tacit knowledge and knowledge transferring is researched. However, seems like this topic gaining interest, since there are very recent studies done on this topic.

5. Methods

This research paper is executed by doing a literature review. Literature review is conducted by searching research papers written about the subject. In this report, we present literature written about tacit knowledge and the use of it in manufacturing companies' asset management and maintenance. VTT's own platforms for literature survey were used to obtain the research material. All research material is derived from research papers and scientific books.

The literature search was carried out by using following keywords: tacit knowledge, maintenance, asset management, management, manufacturing, CMMS, forest industry, enterprise resource planning, maintenance management system, industrial engineering. The keywords produced many results, but most of them remained irrelevant for this specific study, since they handled themes from a different perspective. The literature was searched with English keywords, and all of the material found is in English. Previous research papers conducted on the subject are also mainly written in English.

The analyzing of the research material happened mostly with qualitative methods, because the qualities, attributes and significance of the literature is reviewed as an entity. When the headline of a possible research material was in line with the research subject, the text was skimmed through and the contents and summary was read. When it seemed like the whole text was suitable for the paper, the text was read thoroughly or partially where needed.

The material was then coded into different themes with NVivo. The coding was used to make the themes easier to access later in the process. The content of the texts was divided into the following themes: asset management, computer maintenance management system (CMMS), enterprise resource planning (ERP), maintenance, manufacturing and tacit knowledge. Some of the text overlapped with one or more themes, which were coded into all categories they fit. Keywords and codes are presented in table 1.

Hierarchical Name	Number Of Coding References	Sum of Words	Sum of Paragraphs
Asset Management	13	1020	24
CMMS	23	1679	87
ERP	13	1008	18
Maintenance	16	1127	43
Manufacturing	12	785	14
Tacit Knowledge	102	9214	219
Collecting	11	1271	24
Storing	26	2203	53
Transferring	13	891	39

Table 1: Keywords and coding references from NVivo

6. Results

The challenges we face today, are the problems of how to capture our intelligence efficiently in organizations (Walker, 2017). The problems with making tacit knowledge explicit lie in awareness and representation. In other words, the knower has to learn to share the knowledge, or the observer has to learn to ask and seek for verification (Michael Eraut, 2000).

On their research Eraut et al., (1998) found that, there are some instances where the employees were sharing more of their tacit knowledge related to work than normally. Such instanced included regular discussion, training mentorship, informal discussions where more 'risky' comments could be made, and crisis situations, and situations in which the person is a presenter with an object, like a picture or a video (Michael Eraut, 2000).

However, even if we can share tacit knowledge of people, they will receive the knowledge differently (Michael Eraut, 2000). Applying one's experience is usually treated with disregard and doubt (Amadi-Echendu & de Smid, 2015). People's own previous knowledge and experiences affect the way they perceive other peoples acquired tacit knowledge. On other words, people may have interpretations from similar experiences, but they may differ significantly. Therefore, people have biases on other people's tacit knowledge. (Michael Eraut, 2000) This is a barrier for the flow of tacit knowledge. Tacit knowledge needs to be transferred in a way that gives rise to the experiences, so the prejudice is not that effective (Amadi-Echendu & de Smid, 2015).

In their research, Eraut (2000) has recognized several situations where tacit knowledge may either be attained, used or both attained and used. The situations include knowledge acquired by implicit learning which of the knower is unaware, knowledge created from events in long-term memory, knowledge concluded by observers of actions made, knowledge which supports quick understanding, knowledge required in transferring knowledge, and knowledge embedded in tasks taken for granted (Michael Eraut, 2000).

Explicit knowledge is the key for creation of new knowledge (Maravilhas & Martins, 2019). Explicit and tacit knowledge complement each other, hence creating new knowledge. The process of producing and

transforming knowledge has four phases: socialization, externalization, combination and internalization (Nonaka & Takeuchi, 1995). This process is more commonly known as the SECI-model created by Nonaka and Takeushi (Figure 1).

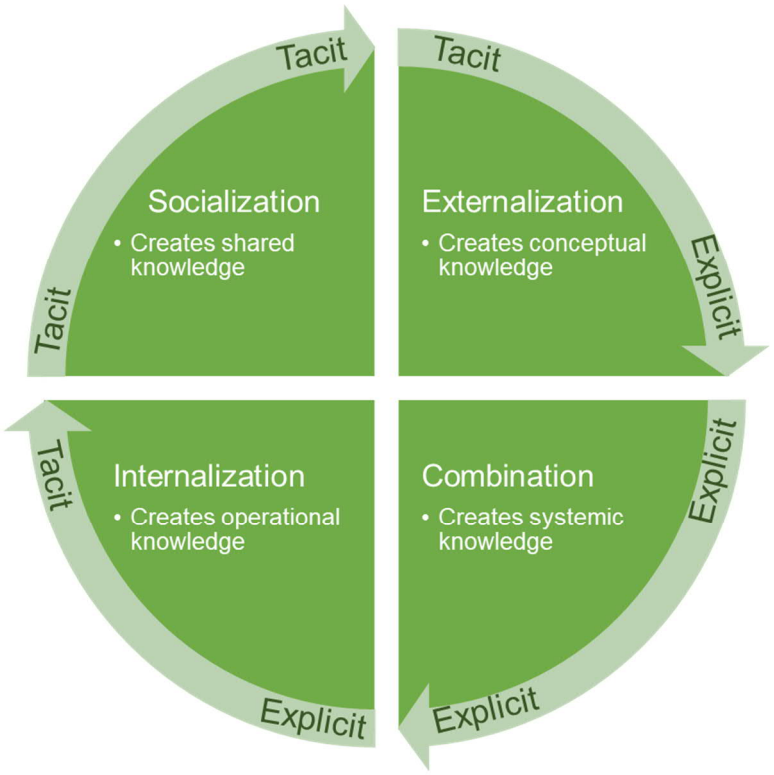

Figure 1: SECI-model (Nonaka & Takeushi, 1995)

The process of transforming tacit knowledge into explicit knowledge begins with socialization, which is a tacit to tacit knowledge transformation. Socialization creates shared knowledge and is an experience sharing process. Following socialization is externalization, which is a tacit to explicit transformation of knowledge. Externalization creates conceptual knowledge through discussion and collective reflection. Combination creates systemic knowledge, and transforms knowledge from explicit to explicit. Combination happens by combining different sets of explicit knowledge in order to create new knowledge. The last phase is internalization, which transforms explicit knowledge back into tacit knowledge. Internalization creates operational knowledge by learning by doing. (Nonaka & Takeuchi, 1995)

The SECI-model has been studied in practice by Maravilhas and Martins (2019), when they studied tacit knowledge sharing in Fab Labs. Fab Labs consist of laboratories located usually in university facilities that together build up a network of laboratories around the world. In Fab Labs, researchers found that tacit

knowledge of the users are shared through in-person observation, documentations, databases, and they learn new knowledge by doing things in the laboratories. In their study, they found that the sharing of tacit knowledge is beneficial due to the motivation and stimulation increase, and creative solutions and projects emerging from diverse people exchanging their knowledge (Maravilhas & Martins, 2019).

Many organizations, however, rely on technology and software on knowledge management. Knowledge sharing and transferring occurs in corporate intranets and extranets alongside wikis, repositories, knowledge bases and document software (Bencsik, 2017). Sometimes, however, the written documentation is not as appreciated as the verbal communication and observation (Maravilhas & Martins, 2019). Additionally, these databases and written data from documents, although being a rich source of data, are rarely searched (Redding et al., 2015).

Written data and information recordings however are a valuable asset to the organizations. They form both the explicit and tacit knowledge asset centers, and with effective capturing, storing and recovering, this data can promote knowledge based learning (Redding et al., 2015). Knowledge sharing could be improved by using databases in assisting the information visualization and filtering results (Maravilhas & Martins, 2019). New software, such as Term Recognition Software, are developed which aim at making qualitative data more available for organizations, supporting their decision making (Redding et al., 2015).

For example, computerized maintenance management systems (CMMS) or knowledge management systems (KMS) are systems that include data of maintenance operations. Maintenance data is important in the forest industry, where machines are a crucial and expensive asset for the organization. Systems can contain data and documents, which include classifying data such as ID's, document numbers etc. In addition, defined technical data can be included in the systems. Some systems provide even configurations to define technical data that can be shared. The selection of the documents for the systems can happen in numerous ways. A management system can monitor the files inserted, and knows who inserted it. Alternative option of monitoring the files a dropbox system, where the user applies the documents of their expertise. (Vertommen & Duflou, 2007). To describe and access this data, there are programming languages such as XML (eXtensible Markup Language) that can be used. (Anderl & Rezaei, 2007)

Big data also is a valuable knowledge resource in organizations and it helps transforming traditional business activity methods. Knowledge of big data boosts decision-making processes, so it should be implemented in organizations knowledge collection processes. Big data can produce value on innovation processes and enable product, process and service development. Big data projects require information technologies that can transfer the data into knowledge and visualize data points. These technologies include programming language tools, and require data warehouse infrastructure, big data analytics platforms and applications. Big data examinations also require IT specialists that are able to use cloud architecture programs such as Hadoop, MapReduce, Semantic Webs and other platforms. Data scientists are necessary for making big data accessible to everyone in organizations. (Kabir et al., 2013) With big data, the collection of tacit knowledge embedded in data warehouses and CMMS and KMS systems can be accessed better and efficiently, since all of the data in the systems can be explored as a whole.

With probability, mathematics and calculation, we can create mathematical models of decision-making situations and store these recordings in management systems, and determine relative merits of different options (Michael Eraut, 2000). The Massachusetts Institute of Technology (MIT) program incorporated "heuristics", which were extracted from previously discovered experience and reflections. The experts often were ignorant of their own heuristics until they applied them in problem-solving situations. Heuristics were defined by mapping different data configurations onto evaluative verdicts (Walker, 2017). If configurations are concentrated in realizations of data, a functional model can be created by using brute force classification. An effective procedure giving the same output as the expert will be produced as a result. (Michael Eraut, 2000; Walker, 2017)

Major shutdowns in maintenance usually improves the ability of decision making to obtain more holistic view of systemic relationships in the organization. Uncertainties and organizational complexities such as major shutdowns make the analysis of the systems more difficult. Enhanced knowledge management systems are needed for better analysis of major shutdown situations. When conducting a research on the knowledge transfer and knowledge sharing during shutdowns, researchers found that there are several faults that occur in knowledge transfer and lead to these shutdowns (Iheukwumere-Esotu & Yunusa Kaltungo, 2020). A one example of a fault tree (FT) was conducted to visualize the knowledge transfer better (Figure 2). In a fault tree, the factors leading up to the shutdown are systematically broken down into occurrences that are more specific. In a fault tree the relationship of the problems are visualized with gate symbols. The top events in a FT are the consequences the bottom occurrences, and when broken down enough, the root causes can be found.

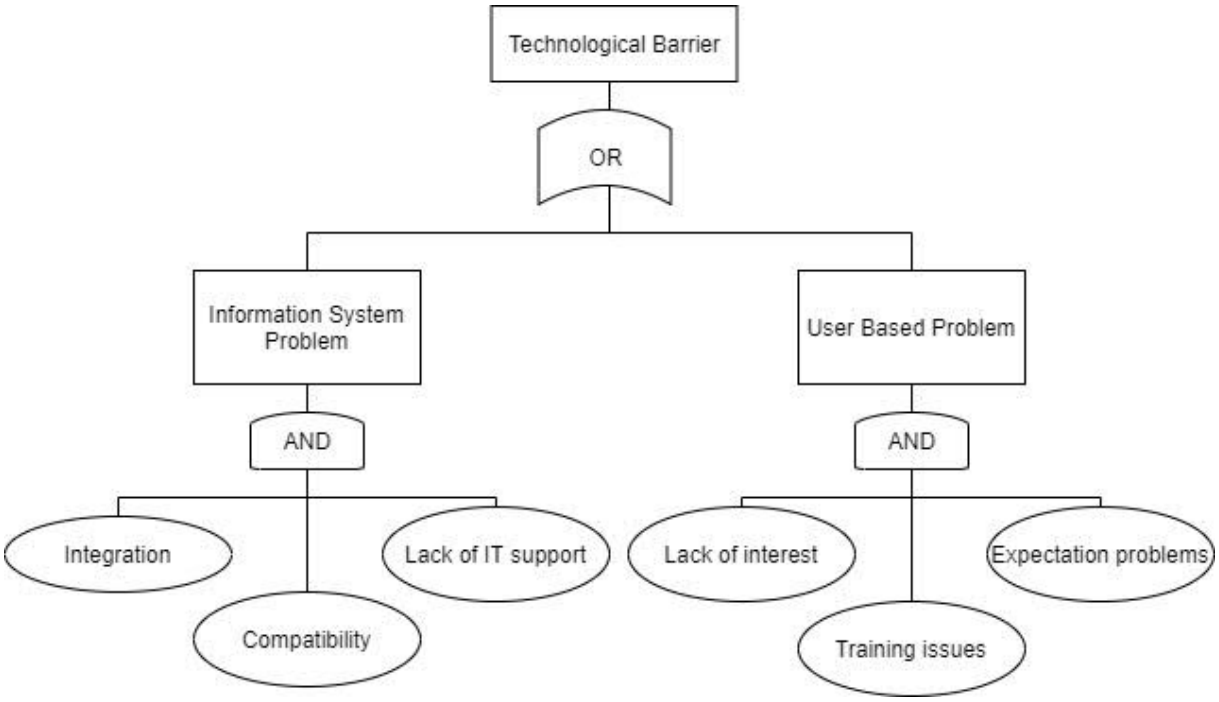

Figure 2: Fault Tree on knowledge transferring leading to major shutdown (Iheukwumere-Esotu & Yunusa Kaltungo, 2020)

Fault trees are useful because of its capabilities to dig deeper into quantitative and qualitative data, and it can give significant insights of the potential causes of major shutdown situations. However, the usage of fault trees in finding knowledge transferring problems has its limits. The people need to be acquainted with the company and its relations in order to make the fault tree as describing as it is, so the people creating and analysing these need to have prior knowledge of their own. (Iheukwumere-Esotu & Yunusa Kaltungo, 2020).

In their study Iheukwumere-Esotu and Yunusa Kaltungo (2020) also visualized the relationships of system reliability and parallel connections using Equivalent Reliability Block Diagrams (RBDs). These diagrams aim at figuring out the connections of components in major shutdowns. RBDs can visualize and pinpoint vulnerabilities and resilience in maintenance systems. Detailed RBDs can also be used to find the knowledge sharing issues on the maintenance functions. RBDs and fault trees together are a hybrid and great way to find more insights on the maintenance functions and their vulnerabilities that lead to major shutdowns. (Iheukwumere-Esotu & Yunusa Kaltungo, 2020).

The main intent in obtaining and using tacit knowledge is to develop tools to model a broader variety of complex systems and support the modelled occurrences better. After all, integration of knowledge has the potential to distribute essential advisory capabilities to product, process, development and life-cycle management. (Pedrazzoli et al., 2007).

7. Validation of results

The literature used in this research was quite limited, and only one database was used to find the literature. Different databases should have been used in order to gain a broader literature to analyse, so the results would have been more objective.

The literature on itself is quite reliable, and most of the articles used were peer reviewed. The source material is fairly new, but also some older material from early 2000's and 1990's was used. Some of these older articles may be outdated, so they must be treated with caution. Many of the articles were also found in a book for collection of lecture notes, which means they were similar themed, and released the same year. These books were brilliant in order to find information on the subject, but they make the diversion of the source material narrower.

As a concept, tacit knowledge is multidimensional. Different articles may have defined the term a bit differently to others, and that might cause some issues in the research. Most authors use tacit knowledge as a catch-all category, which is deliberative (Michael Eraut, 2000). The term of tacit knowledge raises questions and while in different articles they have the same goal, they might be defined and treated slightly differently.

Even though the term and definition of tacit knowledge has remained similar for a long time, the understanding of tacit knowledge has improved over time. In our rapidly changing and developing world, the meaning of tacit knowledge has changed. Therefore, older material and literature must be reviewed critically. With today's software and knowledge, the mining of tacit knowledge can be improved in ways that in early 2000's it was impossible to even imagine.

Even though the source material could have been more diverse, a great deal of information was found. Based on the literature and source material a great deal of ways to share and transform tacit knowledge was found. The goal of this research was therefore met, and it was successfully done. However, taking the issues found into account, there are things to be improved in this particular research. Further research of this matter should be done, and more case studies of tacit knowledge sharing and transformation in the manufacturing or forest industry would be appreciated.

8. Conclusions

Problems with transforming tacit knowledge into explicit knowledge lie in awareness and representation. Learning to share and observe is the key to finding tacit knowledge in different scenarios. Several scenarios where tacit knowledge is present have been identified: when knowledge is acquired by implicit learning which of the knower is unaware, knowledge is created from events in long-term memory, knowledge is concluded by observers of actions made, knowledge supports quick understanding, knowledge is required in transferring knowledge, and knowledge is embedded in tasks taken for granted.

Transforming tacit knowledge to explicit is based on four steps: socialization, externalization, combination and internalisation. This model is called SECI model and it forms a continuous loop of these steps. On every stage of the loop, knowledge is transformed between tacit and explicit knowledge. Sharing of tacit knowledge and the transformation of tacit knowledge has been regarded as beneficial since sharing knowledge between diverse people enhances motivation, increases stimulation, creative solutions and knowledge based learning.

This tacit knowledge is hard to reveal, but there are situations where people are more prone to share their knowledge. These instances are for example informal situations, where employees dare to take more risk in their social interactions. Other situations being for instance an emerging crisis, a regular discussion in a trusted environment or a mentorship. An object or a picture could also support tacit knowledge sharing.

In industrial corporations knowledge sharing is mostly done with databases, wikis, intranets and extranets. Knowledge sharing still remains a bit superficial. Logs and other inputs to the ICT-systems should be analysed better for more effective usage of the tacit knowledge embedded in people and their work. Analysing can be executed with mining tools and tricks. Mining enables better analysing of valuable written information. However, this information might not include all the tacit knowledge the employee has.

CMMS and Knowledge Management Systems (KMS) are a good start to search for knowledge prevailing in organisations. Mathematical calculations from the data inserted in these systems can also be executed, which can be used to help in decision-making processes. Mathematical heuristics connect existing knowledge with new one, helping organizations to mine tacit knowledge.

In the forest industry and manufacturing companies, the tacit knowledge could be collected with the methods introduced earlier. With assets and asset management, the machines usually have logs and other data collection and operating software. The data and especially the qualitative data should be mined more and better and the inputs should be more describing, so that the information flow is better.

During major shutdowns RBD and Fault Tree (FT) implementation is a great way to find out more insights on the maintenance functions and their vulnerabilities that lead to major shutdowns. These tools can be integrated to find the issues on knowledge transferring at different stages of maintenance functions. RBDs and FTs however need specialists that have enough knowledge on the functions, to find the root problems of major shutdowns.

Even though tacit knowledge could be shared and transformed efficiently, there is always prejudice against other people's tacit knowledge. This prejudice is because everyone has a different perceptions and views of life. At least everyone has different experiences, so other people's knowledge on then might cross roads with their own perceptions. Additionally, even if we do everything right in mining tacit knowledge, there is always knowledge that is hard to uncover.

9. Summary

Knowledge is subjective, and tacit knowledge exists in people's heads. Tacit knowledge is acquired from experience and practice, and embedded in routines. Creation of new knowledge comes from connecting explicit knowledge with tacit knowledge. The biggest problem of knowledge creation is collecting the tacit knowledge of people.

The goal of this research was to discover where tacit knowledge exist, how to collect it and how to integrate it with existing knowledge. This research is a part of the SEED ecosystem project. The research is a literature review, and it is executed by studying literature on tacit knowledge, asset management and maintenance in forest industries.

Based on the results, sharing tacit knowledge is difficult, since it is embedded in people's heads, and sharing and transforming tacit knowledge into explicit is hard. However, studies have shown that employees share tacit knowledge in informal or crises situations better. This knowledge can be transformed to explicit knowledge and connected to previous knowledge with steps introduced in the SECI model. Alongside of transforming tacit knowledge to explicit knowledge tacit knowledge can be found in the companies ICT systems. Finding of this knowledge can be done by exploring data in the organizations ICT systems, knowledge managements systems, and computerized maintenance management systems. Mining this big data can be done with programming and mathematical heuristics. During major shutdown situations, the flow of knowledge can be visualized with fault trees and Equivalent Reliability Block Diagrams (RBDs). Sharing tacit knowledge in the forest industry could be improved with mining maintenance systems and interviewing employees.

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