

Identification of Tacit Knowledge Associated With Experience: A Chinese Software Industry Study

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Abstract: This paper reports on a research project that aimed at identifying the professional and personal experience from individuals in the SMEs in the Software (SW) industry sector in China. This study employed an inductive qualitative approach based on a single case study and grounded theory (GT) data analysis. The SW company is a SME that specialises in multimedia SW research and development and is located in Xiamen City (Fujian Province, South of China). Six participants, selected on the basis of their role in SW design and development, were interviewed using a semi-structured interview script. These in-depth interviews ranged from 100 to 120 minutes in length. After completing the open coding of the six interview transcripts, the researcher obtained 121 codes and 215 quotations from the interview data. These codes were grouped and organized into a category hierarchy that included 6 main structured categories as the result of axial coding. The results of the study enabled the development of a taxonomy and classification of tacit knowledge related to experience in the different stages of the SW development process. The study also showed that each identified category of tacit knowledge is not necessarily confined to one specific SW development stage or even to a specific role in the process. This emergent theory challenges traditional perceptions that each stage requires very precise types of skills, experience and even types of individuals.

Keywords: tacit knowledge; professional experience; tacit knowledge identification; software development process; Chinese software industry

1. Research background

Knowledge has played an extremely significant role in improving competitive advantage in the era of the modern information society (Amalia & Nugroho 2011). As such, knowledge has long been recognised as a valuable strategic asset and its management, known in the literature as Knowledge Management (KM), as an essential business tool. The basic principle of KM is creating and sharing knowledge in organisations in both tacit and explicit formats (Renzl et al. 2005). Whilst explicit knowledge is valued, most practitioners and academics believe that the most valuable knowledge assets are embedded in tacit form by the individuals within the organisations who developed and internalized it through experience (Mooradian 2005). Since tacit knowledge can only be acquired and developed through human experience during work activities (Lam 2000), it is extremely hard to capture, represent and maintain in forms that can be useful for organisations.

However, the key issue here is a lack of research aiming to define and identify how professional and work experience can be represented as tacit knowledge so that it can be codified, classified and shared in real working practice. This is particularly true in the software (SW) industry sector where concerns have always been more on technical issues rather than on soft issues such as knowledge sharing (KS). Therefore, there is a need to research on what aspects of professional and personal experience in the mind of the SW development practitioners can be codified in order to maintain the sustainability and success of SW organizations. This is of particular concern in one of the industry sectors with highest staff turnover and lowest company survival rates. This paper aims at being an early contribution to the identification of tacit knowledge related to individuals' experience in this sector.

2. Research methodology

2.1 Research question

This study aims to provide a bridge between tacit knowledge and professional and personal experience, as well as to capture and organise these aspects into an explicit classification – an ontology - that can be used to capture the tacit knowledge and codify it into explicit knowledge. Since such ontologies are always closely related to actual contexts of practice, the researcher needed to find a concrete context in which to apply these ideas.

The Software/IT industry sector in China was identified as ideal for this study as the researcher in the team has had experience working in sector and still retains good contacts that enabled access to the case-study company. Furthermore, as claimed by Fagri et al. (2010), software companies require collaborative and knowledge-intensive work that depends greatly on the experience of their individuals. Therefore, from a theoretical perspective, this sector seemed ideal for this study.

The Chinese software industry will take an increasingly important role in the global software market and this makes the selection of the Chinese context particularly meaningful. This expected growth also means that the findings of the research will also be significant and useful for the industry and have potential impact in terms of research dissemination. Therefore, this environment influenced and shaped the research question for the study that was formulated as follows:

What is the tacit knowledge related to experience within the working practices of the software/IT industry in China?

2.2 Research design and approach

In attempting to respond to the above research question, this study employed an inductive qualitative research approach and a research design that consisted of a combination of grounded theory (GT) and a case-study.

2.2.1 Case-study

Case-study analysis is a common approach in the social sciences used to explore and understand complex and localized human activity systems and social environments. According to Yin (2003, p.13), the case-study is particularly useful since social phenomena are not always distinguishable from real life situations and the researcher wanted to cover contextual conditions that they see as highly pertinent to the study of the phenomenon. That is exactly the case for this research, since tacit knowledge associated with experience in the SW industry sector can only be studied in companies in the sector.

Specifically, in order to respond to the research question, this study adopted a single case-study of a SMEs SW company, called BAIDUCHUAN Information Technology Co., Ltd. BAIDUCHUAN is a multimedia software research and development company, founded in September 2010 in Xiamen City (Fujian Province, South of China). Their business scope includes multimedia software for PC/TV, Android system application software, Android application operations, and navigation application for smart handheld devices. These products can be implemented in Tablet PCs, computers, TV computers, car computers, and are mainly used for home entertainment, business use, hotels, and karaoke clubs. BAIDUCHUAN has also a special relationship as the multimedia software supplier for the Malata Group, which is the largest hardware manufacturing company in Xiamen and has nearly 20 thousand employees. BAIDUCHUAN has around 12 employees, but by the time of the interviewing, the company had a number of empty positions waiting to be filled after the Summer break.

There were two main reasons behind the selection of this Xiamenese Company as case study. Firstly, the company is a privately owned company and that meant that the researcher could get easier access guaranteed than in State-owned companies which have a heavier hierarchical structure and pose more bureaucratic barriers. Secondly, the company is a rather small SME which was ideal for the researcher to find a diversity of roles that concentrated on a fewer number of interviewees in a simpler business environment.

However, as recognised by one of the most prominent proponents of case-study approach “the strategies and techniques have not been well defined” to collect and analyse data from case-studies (Yin 2003, p.109). Therefore, the use of case study is often combined with other methodologies. In the case of this research, it was deemed that using grounded theory (GT) to complement the use of case-study by providing the necessary methodological support for data collection and analysis.

2.2.2 Grounded theory

Grounded Theory (GT) is widely considered as the most frequently used qualitative analysis rooted in the inductive approach (Saunders et al. 2003, p.93). It was first developed by Glaser and Strauss in 1967, in order “to generate theory through the systematic and simultaneous process of data collection and analysis”

(Goulding 2002; p.170). To be more specific, the theory is generated from qualitative data which is collected within particular social contexts and directly from the participants in the phenomenon being studied, without bias of preconceived theoretical frameworks.

Moreover, GT is designed for generating theory where little is known about the particular areas, or which can “provide a fresh slant on existing knowledge” (Goulding 2002, p.42). It has been proved and highly recommended as an effective method in IS/IT research, which enables the investigation, analysis and explanation of “the socio-technical issues in software development” (Lings & Lundell 2005, p.197). Therefore, it is appropriate for research that addresses emergent and new issues that have limited cover in the literature review or aspects of more established theories that have been ignored or not addressed in-depth. This is exactly the case of this study and therefore GT was deemed to be a very suitable approach. Additionally, GT provides a clear structured process, specific analytic methods and flexible guidelines that provide good support to systematically and intensively collect and analyse data (Charmaz 2006, p.5). Therefore, it was deemed to be ideal to complement the use of case-study by providing the necessary methodological support for data collection and analysis.

2.2.3 Data collection and analysis

Semi-structured interviews were designed as the data collection technique to gather in-depth data to respond to the research question. The structure was constructed by following the SW development process illustrated in Figure 1. This process of software development is very useful to understand the complexities of software engineering and identify the very different skills, competencies and experiences necessary in the sector. This view is supported by Pfleeger and Atlee (2008, p.47), who claim that these processes were “important for enabling us to capture our experiences and pass them along to others”. Therefore, in order to identify the experience and tacit knowledge in the process of developing software, this study used this process to inform data collection and help in the design of the semi-structured interview scripts.

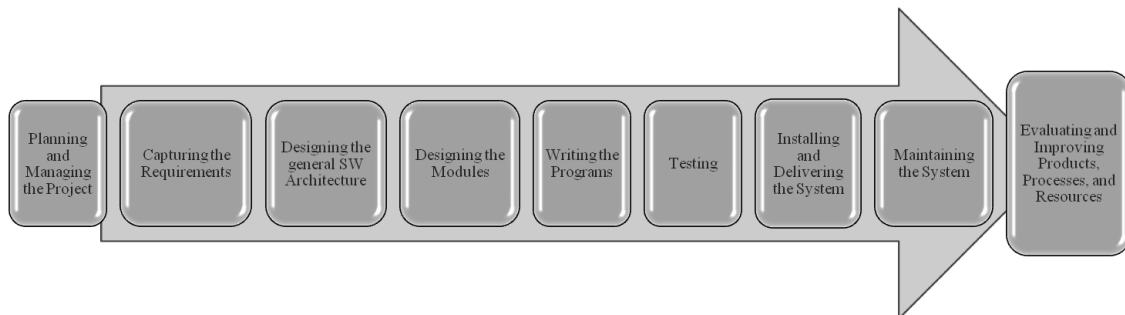


Figure 1. Main operational and management activities as identified

Interview questions themselves were open-ended which enabled the researcher to focus on the more significant questions and to elicit substantial perspectives, opinions and ideas from the interviewees. All questions were originally developed in English and then translated into Chinese. The English questions aimed at allowing discussion of structure and design among the predominantly English research team. The Chinese translations are used to interact with informants during the interview process. Prior to the interview, each interviewee received introductory information about the purpose of the study, and consideration of ethics issues like confidentiality and anonymity.

Overall, there were six participants. The sampling was devised so that informants from the SW development practitioners in the company, namely: two senior managers, one project manager, two developers, and one content manager. Interviews were conducted in Mandarin Chinese and generally ranged from 100 to 120 minutes in length. All interview processes were digitally recorded and then transcribed word-by-word into Word files after the completion of each interview.

Each interview transcript was manually analysed according to the procedure of GT data analysis methods, which contains open coding, axial coding and selective coding:

- Open coding is the initial step in the data analysis which draws out from the text and labels “the key issues within the data” (Cameron & Price 2009, p.417). It is more than just labelling, it is also formulating a theoretical language which describe the meaning from participants (Cameron & Price 2009, p.417).

According to this research's question, the codes were identified from activities described by participants, where experiences determines use or acquisition of tacit knowledge during the SW development process.

- Axial coding is the subsequent step to open coding, which aims to "look for relationships between the codes, for areas that are connected, for concerns that seem to be linked." (Cameron & Price 2009, p.419). It is a process try to associate and relate concepts represented by the codes into group concepts and these into identifiable categories. In this research, the axial coding process consisted of grouping related ability, skills or experiences associated working practices in the SW Industry.
- Selective coding is the step to "draw together the categories and the relationships between them to produce" the results from research (Cameron & Price 2009, p.422). It is the process to identify the core category that could tie other categories, and also integrate the categories that can be contributed to the theory. Moreover, the poorly developed categories are identified, which will indicate the further theoretical sampling and data collection. This coding process in this study produced *Experience* as the core category.

3. Research findings

After completing the open coding of the six interview transcripts, 121 codes from the interview data were identified. These codes were grouped and organized into a category hierarchy that included 6 main structured categories as the result of axial coding (Figure 2):

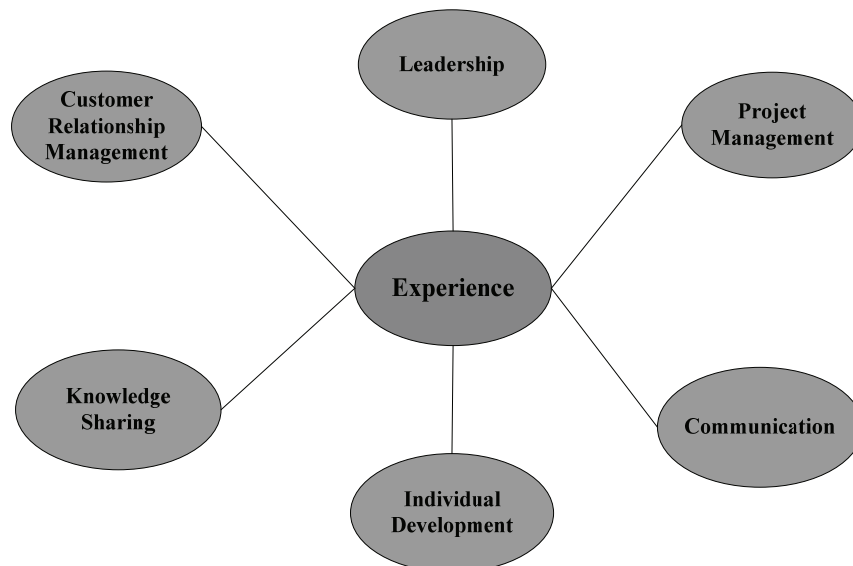


Figure 2: Concept map of main categories

3.1 Leadership

One of the categories that was more explicitly mentioned in the interviews by both project managers and developers was leadership. Leadership seems to influence both the outcome of the projects and the harmonious work in the project teams, as well as being identified to have an impact in employee's daily working practices. Experience and knowledge can facilitate the leadership in company management as well in development projects.

From the management perspective, it is important to aware that leading a team aims to fully use everyone's ability and decrease individual's shortcomings. As stated by a Senior Manager:

"There is an advantage from the teamwork. That is the company could provide different things, like ideas, teaching, tips, or assistance, which will minimise the disadvantages or inconveniences from individuals. This is one good reason to have teamwork." (I4.7.13.M)

Moreover, understanding and knowing colleagues are significant factors in the success of teamwork. For instance, one of the interviewed project managers stated:

"One important issue is the understanding of my colleagues. It includes according to this understanding, I can make reasonable arrangements and distribution of tasks." (I1.4.21.PM)

This same project manager was of the opinion that “people also can be considered as one kind of resource” (I1.3.6.PM), which needs to be managed. In order to “get a variety of people to work together” (I4.7.37.M), one Senior Manager needs to “consider how to coordinate them” (I4.7.37.M). Because “many programmers have different levels of ability and communicating skills” (I4.7.37.M).

From the technology perspective, SW design and development is an activity that is very technical and produces a tangible artifact that needs to conform to both a requirement specification and the socio-technical environment in which it is going to be used. It is therefore crucial that leaders clearly understand the nature and role of testing in the project. This will determine the choice of testing approach, method and the composition of the testing team. One of the project managers claimed that:

“Unit testing requires relatively low connection to coding from a macro perspective. Because each functional module is relatively independent, and not closely connected with each other, we can test them independently. In this sense, it requires relatively higher quality of coding by programmers.” (I1.10.28.PM)

Realistically, the selection of testing method and team were fully depended on the company size and resources from the leaders’ judgement.

“For now [we only do unit testing], there are problems of time and with the external environment, so we do not have the necessary conditions for system testing.”(I1.11.2.PM)

3.2 Individual development

Individual development was identified as a crucial aspect in a very fast changing and evolving field, where technological, methodological and sometimes philosophical trends seem to come and go periodically. Therefore, the capacity and motivation for self-development was identified by almost all of the participants as a crucial factor for their professional success.

“Because like software, the software development technologies update very fast. Many new technologies continually appear. If you do not have a strong self-learning ability, then you will not be able to catch up.” (I6.2.35.D)

“It requires some technical skills and needs continuous learning. Because the IT industry is changing so fast ... it changes almost every 8 months or so. I should keep an attitude that I need to constantly learn and understand the new technologies.” (I4.3.18.M)

However, the motivation for learning and self-development is not the only elements that were identified in individual development. A great variety of aspects and personal skills was referred to, such as Working in Project Teams, Recording and Reflecting on Activities, Knowledge Sharing Habits, Professional Attitude, Self-Confidence, Reuse of Information and Resources, Specific Professional Ability, and Building and Maintaining Professional Social Networks. Therefore, the capability for developing comprehensive experience is significant to work for the SW project.

3.3 Project management

Project management is a permanent feature of the design and development of SW products and services. For a manager, it usually includes activities such as to plan, organize, motivate and control the process of development, as stated by a senior manager:

“In fact, for the entire project, it is important to control the plan. In the other words, it is to control the developing and the progress of project.” (I5.7.34.M)

As a consequence all the interviewees had very strong opinions on project management activities and the skills and experience that are necessary to make a project succeed. As stated by the project manager:

“Before assigning the tasks, in my own heart, I have set the bottom line of time, including the upper and lower limits. Since I have done SW developing so many years, I can figure out how much time is needed for the tasks.” (I1.2.35.PM)

“Usually, we will break down a project into several small pieces of tasks. After that, I will assign tasks to the person, according to the situation of the project, including the different abilities of individuals.” (I1.2.32.PM)

However, estimation management is not the only perceived responsibility of managers. They also have the responsibility to monitor, manage and support each of the project members. Additionally, it is expected that all members, including the project manager, understand the work breakdown structure and activity sequence of the project as expressed by one of the developers as follows:

"[...] Let's say it's a problem of sequence. Because various projects have different patterns of operation. Every different situation could happen. When we implement one project, we may plan the sequence of task in a particular way. But we may find out that this sequence is not suitable for the next one. In this situation, we need to change, in order to enhance the effectiveness and speed of development."(I2.3.15.D)

It is therefore clear that every individual no matter whether a manager or not, is always required to have high awareness of project management, not only in terms of their own work, but also of the whole process and sequence of tasks.

3.4 Customer relationship management

The main business of SW companies is usually associated with software supply in terms of both products and services. According to participants' perspectives, the data analysis identified customer satisfaction as the main criteria on SW successful acceptance. This point was very strongly supported by one of the Senior Managers, who claimed that:

"The more communication with customers, the more I could understand why we do the software, and what makes the software valuable to them. That is, no matter how good the development of your software is, if no people pay the bill, then it is not useful. By contrast, if the software is not well developed, but the customer is satisfied with it, then it is good software." (I4.2.12.M)

Therefore, there is a need to build and maintain close and trustworthy relationships with customers and as such customer relationship management was seen to be paramount in guaranteeing and sustaining success. Moreover, in order to maintain this relationship, each individual provided different point of views, for example:

"We are the first contact with customer. In this case, we should have a better understanding of customer. And then in the process of discussion, we attempt to establish an interactive understanding between each other." (I2.7.29.D)

"The techniques of questioning the customer must be right. Otherwise, there would be a lot of nonsense talking without getting the real demands from customers. [...] It should hit the nail on the head, and be very professional." (I6.6.41.D)

3.5 Knowledge sharing

Knowledge sharing was also identified as an important activity for individuals in their SW working practices. It was highly recommended as "a process of exchanging [ideas], which can produce new knowledge." (I2.13.33.D) In this study, Knowledge sharing did not seem to be confined to the boundaries of the company, but also involved friends, web based communities of practice (CoP), professional networks and even competing organisations. Evidence of this sharing practice was evident in the project manager's statements:

"Basically [...] the previous colleagues I have been working with for several years, and are still working on very similar areas ... sometimes intersections between us leads to knowledge sharing. Thus, we often have discussion and exchanges." (I1.3.27.PM)

"[...] another sharing group is former classmates. Some classmates of mine also work in this industry, and since we have the same interest we can talk and communicate."(I1.3.30.PM)

Similarly, one of the developers proposed:

"[Sharing with people who] are on the internet, like some communities. I always go to communities like ZHIHU. This is the most popular community where people can discuss a variety of issues, not only IT, but also other issues. However, discussion about IT is the predominant topic." (I2.5.12.D)

ZHIHU (<http://www.zhihu.com/>) is a Chinese community for questions and answers on different technical issues, which is public and open for everyone. For a junior SW practitioner, when the friends circle and professional network are not strong enough, the CoP seems to be an ideal platform to share and exchange

ideas with others. Therefore, it seems that according to the perceptions of the informants the capability for knowledge sharing is very important for SW practitioners no matter if they are experts or novice.

3.6 Communication

Communication was identified as the activity to convey information through the exchange of thoughts and messages as fully illustrated by a project manager, which explicitly mentioned face-to-face, formal documents, instant messaging, telephone and email. The same project manager also differentiated the use of these media:

"The specific role of [face-to-face] communication is that we can timely collect feedback from each other, and make some rapid adjustments." (I1.14.6.PM)

"For example, customer requirements are better presented in written format. [...] then there is evidence during the project process." (I1.13.43.PM)

"For example, chat software certainly, it is timely, most timely, and provides relatively high feedback. It is relatively less formal. Moreover, it can enable deeper talking, but less systematic. If there is a large number of information, then MSN communication may help my own work."(I1.14.16.PM)

Additionally, the data analysis also showed that the way to communicate with customers, colleagues and boss are difficult skills and require solid experience. Consequently, the ability to communicate and negotiate is perceived by the informants to be crucial for every individual no matter if they are a technical developer or an organizational manager.

4. Discussion

4.1 Challenging the traditional perceptions of compartmentalisation of experience in SW development

The six main categories identified are general activities described by participants, where experience determines use or acquisition of tacit knowledge during the SW development process. However, the theoretical sensitisation for this project proposed very different and identifiable stages in SW design and development. The interview script was therefore built around these stages as shown in Figure 3. The analysis of the data of this study resulted in the six horizontal categories that seem to be transversal to the process as shown in Figure 3.

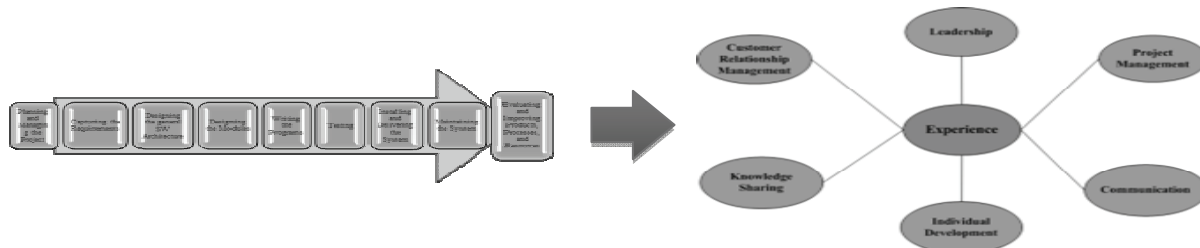


Figure 3. Challenging of traditional perceptions of compartmentalisation of experience in SW development

The traditional view of SW development seemed to indicate a compartmentalisation of types of experience allocated to a specific phase. For instance, a story reflecting on the experiences of a programmer may be of very little use to an analyst and vice-versa. However the findings of this research indicate that aspects such as customer relationship management, knowledge sharing or individual development seem to require experience and tacit knowledge that is not necessarily confined to one specific stage. This seems to challenge traditional perceptions that each stage requires very precise types of skills, experience and even individuals. That is, the findings of this research challenge the traditional understanding of SW development practitioners, by proposing, for instance, that technical developers should not only be good at technical work, but also have the ability communicate and negotiate with customers, communicate with leaders and peers and take responsibility for self-development. For example, a project manager highlighted the value of experience when communicating with customers during the capturing the requirements.

"It is important to understand customer's intentions when I communicate with our customers. For example, they may want something a little bit different from the design draft that they did by themselves. In another case, something they want is not reflected in the design draft. These

require further communication with customers, because in the process of communication, I can understand what kind of thing that they really want, even if it is different with what they speak out." (I1.5.7.PM)

More interestingly, one of the senior managers even made a clear that "the technology is fundamental, but not the key. [...] From the perspective of business, I would say that resources are much more important than technology" (I4.4.13.M). This perspective was supported by a developer who also claimed:

"In the company, the relationship between colleagues is very important. Because the technology is not necessarily the foremost issue. In fact, in teamwork, interpersonal relations are first, technology is the second, I think." (I6.13.6.D)

These findings were very interesting in themselves, but also confirmed that the inductive approach adopted by using GT seems to have been very successful. The emergent theory seems to be indeed grounded in the context of case-study rather than the prevalent literature review. In this sense the findings of this study are very different to those that would have emerged from a deductive approach (for instance a questionnaire based survey) that would either prove or disprove a priori defined theories deduced for the existing literature in the field. Therefore, the choice of GT for this study seems to have been appropriate. However, as any other social science case-study research, there are limitations in terms of generalisation and use of the emergent theory in other contexts. This type of study does not aim to develop universal and generalizable theories, so the findings of this study are expected to be transferable to similar contexts, but require further confirmation and applicability studies.

4.2 Willingness of the participants

Before conducting the interviews for this study, the researcher had concerns that the SME employees would not cooperate willingly, because of a perception that programmers and technical individuals may not be interested in this type of research or not be willing to express or share their experiences and tacit knowledge. In fact, the participants showed their appreciation for having been provided with a chance and platform to rethink and recall their previous experience and previous working practices. Time and space for this reflection on their own practices and experience are difficult during their much pressured daily work routines. This research seems to have helped them to enhance their own understanding of their personal experience and one of the participants (Interviewee 2) has even asked for the digital recording of his own interview. Another indication of success of the interviewing process was the engagement of interviewees with the answers, causing all interviews to last more than the planned 60 minutes. One last symptom of this success was the request of the senior manager of this company for the report and results from the research, which he wanted to make the basis for future recruitment of staff.

5. Conclusion

This study was contextualised and grounded in the process of software development and aimed at providing an ontology or classification of the tacit knowledge associated to individuals' experience within working practice in SW industry sector. The ontology of the six horizontal categories was identified in this study and could enable a structured approach for the transference of tacit into explicit knowledge, which can then be systematically managed. Although significant contributions have been proposed, the research findings presented above should, however, be seen as a first step in the understanding of this problem area. A more comprehensive definition of the ontology and classification proposed here should be developed and improved until the theory generated is better equipped to be useful in practice. Future work will consider further inductive research into a more rich variety of possible contexts (e.g, including SOE and larger SW companies), which could provide further insights or contrasts as determined by a good theoretical sampling practice.

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