# Knowledge Management in Globally Distributed Software Development Teams: Sensemaking Challenges

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## ABSTRACT

Offshore software development presents a variety of knowledge management challenges. In this paper, we aim to improve our understanding of knowledge management challenges faced by globally distributed software development teams. Case study findings are analysed across two phases of initiation and growth. In the initiation phase we identify sense making challenges and the growth phase presents practices that were undertaken to cope with the challenges. The paper contributes the theoretical concept of imagination to the sensemaking literature as well as advancing our understanding of practices to overcome knowledge management challenges.

**Keywords**: Interpretive case study, team, project, longitudinal, software development, outsourcing.

## I INTRODUCTION

Previous researchers posit that communication breakdowns between globally distributed team members in offshore software development are related to insufficient exchange of documents for communicating the rationale behind requirements (Vlaar et al., 2008), diverse specialized knowledge (Leonardi and Bailey, 2008) and cultural background (Levina and Vaast, 2008). Scholars remain skeptical on the capacity of ICTs to enable communication of knowledge in offshore software development due to communication breakdowns (Bjorn and Ngwenyama 2009) especially some or all the software development and maintenance task ranging from simple programming to complete software design and development are sent offshore (Sahay et al 2003).

Prior research has shown one of the related issues in managing offshore relationships is managing knowledge (Aman and Nicholson, 2009). Current research in offshore software has focus more on knowledge transfer (Sahay et al 2003,) and embedded knowledge (Nicholson and Sahay 2004). Knowledge transfer about products, processes and practices to the offshore development team is crucial (Sahay et al 2003). However, there is no explicit knowledge transfer taking place directly from the offshore site to the client, other than the transmission of information required for project monitoring and control because of its 'stickiness' (Sahay et al 2003).

Knowledge has been defined in different ways but in this study, knowledge refers to the knowledge owned and required by each of the stakeholders; client, onshore teams and offshore teams in offshore software development context. Knowledge is understood as comprising of tacit and explicit dimensions that are both owned and required by software development team members (Walz et al. 1993). Tacit knowledge is "non-verbalizable, intuitive and unarticulated" (Polanyi 1962) and highly context specific (Nonaka 1994). On the other hand, explicit knowledge can be codified, acquired by formal study and aggregated at a single location, as well as appropriated without the participation of the knowing subject. Understanding knowledge as tacit and explicit opens the possiblity that there are aspects of knowledge in the software development process that cannot be articulated but that may be crucial.

Globally distributed team members have to share knowledge with members from the same site and integrate knowledge situated in a range of sites (Sole and Edmondson 2002). Lam (1997; 2000) posits that differences in the degree of 'tacitness' of knowledge are caused by the ways in which knowledge and skills are formed, organized and utilized in various social settings. Knowledge may be "embedded" in particular locations and attempts at communicating knowledge across boundaries of time and distance can be highly problematic (Nicholson and Sahay 2004).

According to Weick (1995), sensemaking refers to the process in which individuals generate interpretation. Weick's (1995) view sensemaking is generated by words that convey what we are experiencing, or in other words, a person makes sense of a situation through thought or ezpressed words that convey what she or he is experiencing. Building on this insight, Walsham (2004) presents a theoretical lens of sensemaking identifying the concepts of sense-giving and sense-reading. Sense-giving refers to the ability to communicate knowledge to another using a medium of communication as knowledge representation. Sense-reading refers to the ability to read the representation of the other person's knowledge that is being communicated.

Vlaar et al. (2008) have improved our understanding of socio-cognitive acts in sensemaking between globally distributed teams. They identify the concepts of sensegiving, sensemaking, sensedemanding and sensebreaking to transfer pre-existing understandings and co-create novel understandings in distributed work settings. However, Vlaar et al. (2008) call for further research on the implication of differences in communicative acts across cultures and the link to sensemaking.

Lowgren and Stolterman (2004) posit that in the early stages of the creation of a software artifact the designer's imagination produces a "vision" of the artifact. This vision follows through the design process and influences subsequent analysis leading to an "operative image" that bridges the abstract requirement to the concrete and complex situation, and is eventually transformed into a specification of the final design. The vision, operative image and the specification influence each other continuously. Following Lowgren and Stolterman's design logic, we posit that a precursor to sensemaking in distributed settings is the designer's imagination, which produces the vision.

This study seeks to improve our understanding of sensemaking in globally distributed software development teams. The following research questions guide our inquiry: (1) What are the sensemaking challenges in offshore software development? (2) How might the challenges be overcome? The empirical evidence is drawn from an interpretive longitudinal case study of a small software firm based in the UK with subsidiaries in Bangladesh and Malaysia. This evidence is analysed and builds on a theoretical framework derived from the concepts of sensemaking (Walsham 2004; Weick 1995).

The paper is organized as follows: the next section presents the conceptual framework. The methodology and the case study background follow this. The discussion and analysis section provides empirical evidence on the knowledge management challenges Conclusion section provides the theoretical and practical contributions.

## II CONCEPTUAL FRAMEWORK

We draw on Walsham's (2004) conceptual lens of sensemaking. We posit in the sections to follow that the interpretation during sense-reading requires imagination to successfully connect to the tacit knowledge underpinning sense-giving. Thus, imagination is a key enabler to accomplishment of sensemaking in offshore software development. However, differences in prior knowledge and cultural background also contribute to sensemaking challenges. Figure 1 presents the theoretical framework.

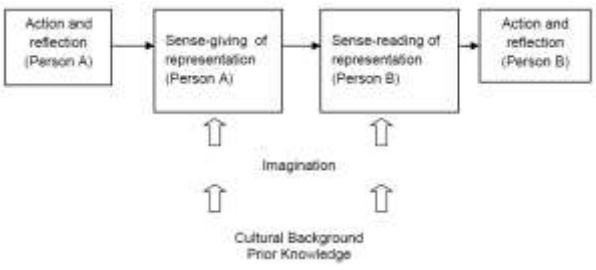


**Figure 1: Theoretical Framework: Sensemaking in globally distributed teams**

### A. Imagination

The concept of imagination has been highlighted by several studies in a wide range of disciplines (Mackenzie 2003). Appadurai (1996) for instance describes imagination as part of the mental framework. Gatens and Lloyd (1999:12) claim that imagination is constituted as immediate "awareness of bodily modification" meaning awareness of other bodies besides our own (Gatens and Lloyd 1999). Dewey (2009: 224) states that "the proper function of imagination is vision of realities that cannot be exhibited under existing conditions of sense-perception". In other words, imagination creates a vision of events or conditions when direct sensory evidence is not available.

Winograd (1995:69) explains that the designer needs to be able to "visualize what the program will be like and what can be done with it, even before it is programmed"(p 69). However, there are limits of explicit knowledge to foster visualization. Winograd (1995) posits that "abstract representation, such as written descriptions, flow charts and object class hierarchies cannot provide a grounded understanding" (p69). Vlaar et al. (2008) explain that by engaging in the communicative acts of sensemaking, software team members may experience "imaginary moments" that may lead to new images, conceptions or accounts of what to do, and how to do it. Lowgren and Stolterman (2004) explain the importance of imagination in early design work in software development. According to them, imagination is required to produce the vision, operative image and eventually the specification. We posit that correspondence between offshore team members with the designers vision depends upon respective prior knowledge and cultural background.

### B. Prior knowledge

Prior knowledge is accumulated through the process of practical hands-on experience and formal education or training (Lam 1997; 2000). It implies a combination of technical knowledge, pre-existing attitudes and experience (Kujawa and Huske 1995).

The experience of designing software for previous projects is stored in long-term memory, which will be recalled and modified when developing that of the current project (Oshri, Fenema and Kortlarsky 2008). Similarly, as Lowgren and Stolterman (2004) point out, if the designer is experienced, an initial vision will emerge early in the process of designing software, as the situation reminds the designer of similar situations from previous design experiences. In offshore software development work, there may be differences in formal education or training of each team member (Hinds and Bailey 2003; Katasonov and Sakkinen 2006).

### C. Cultural Background

Culture may be understood as a pattern of symbolic discourse and action (Walsham and Waema 1994) and the way in which a group or community understands the world as a result of shared common experiences (Sahay et al. 2003). Managing culture has a large and expanding literature in information systems (eg. Leidner and Kayworth 2006). Of relevance to sensemaking are aspects of questioning behaviour and language.

Questioning is vital in the process of communicating knowledge for the affirmation of interpretation and thus accomplishment of sensemaking. According to Lowgren and Stolterman (2004), a designer has to ask questions

and critically examine assumptions and preconditions to ensure the understanding of the existing situation. Without questioning, a team member may continually strive to incorporate new knowledge into existing understanding (Kang et al. 2007; Vlaar et al. 2008).

The use of language is important for effective questioning and coordination of action with others during the process of software development, if an utterance is not intelligible to others, communication breakdown occurs (Winograd and Flores 1986). Individuals who share prior knowledge using the same language can more easily make sense of what is being communicated to them (Winograd and Flores 1986).

## III RESEARCH METHOD

A qualitative longitudinal interpretive case study approach was followed (Walsham 2006; Klein and Myers 1999) that spanned a period of two years from 2002 to 2004 following several software development projects over time. Historical reconstruction of events was undertaken to observe changes over time from the inception of the company's offshore centres from 1997 to 2002, during the field study period from 2002 to 2004 and an interview with one of the company directors in 2009.

Das was founded in 1994 in London. The company started as a software consultancy for London based clients. In 2009, Das had around 200 staff in UK, Bangladesh and Malaysia. Das (UK) acts as a parent company to both the Malaysia and Bangladesh subsidiaries. Das (Bangladesh) became the wholly owned software development centre serving both Das (UK) and Das (Malaysia). The onshore teams in UK interact with clients, prepare requirements lists from gathered data, design the software and finalize the Functional Requirement Specifications (FRS) before sending to Das (Bangladesh) for technical design and coding. Das (Bangladesh) develops software for Das (UK), Das (Malaysia) and undertakes local projects in Bangladesh.The offshore teams in Bangladesh do not have direct interactions with Das's clients in the UK or Malaysia.

Data collection methods included interviews, internal document review, archive e-mails and e-chats and observations during fieldwork at the offshore sites in Malaysia and Bangladesh. At least ten days were spent at each of the offshore sites. Semi structured interviews were undertaken with 18 individuals at various levels in the organisation including deputy director, country manager, project manager, team leader, senior developers and system administrator.

The interview questions focussed on company background, description of offshore software development projects, why and how they were undertaken offshore, project management approaches and problems encountered during the process. Each interview was conducted face-to-face for up to two hours, 34 hours in total. Details of the interviews are summarised in Table 1.

**Table 1: Interview Details for Das**

| Period of Data Collection | Location | Number of Interviews |
|---|---|---|
| January to March, 2002 | UK | 2 |
| | Malaysia | 2 |
| December, 2003 to February, 2004 | UK | 1 |
| | Malaysia | 2 |
| | Bangladesh | 11 |
| August, 2009 | Malaysia | 1 |
| | **Total** | **19** |

Data from interviews, observations and documents were coded using the open coding technique, which adopts a form of content analysis where the data are read and sorted into categories suggested by the data (Strauss and Corbin 1990).

## IV ANALYSIS AND DISCUSSION

The analysis focuses on several episodes of sensemaking between the onshore teams in the UK with the offshore teams in Bangladesh. In the episodes to follow we explore the early stages of the offshore outsourcing focusing on sensemaking failures. In this early phase, the UK team is responsible for design of the artifact, while the Bangladesh team performs coding and technical analysis. On several occasions, lack of corresponding shared vision of the artifact results in inaccurate design assumptions and programs that did not meet the requirement. In the words of the UK based director:

*"We have had a problem here in that what they (offshore teams) delivered to us is a total crap. We send it back and it takes so much time again to fix it." Clara, UK Director*

The Bangladesh team lacked sufficient domain and prior knowledge to enable their imagination to envision the software artifact. According to one of the offshore senior developers:

*"In the project with the UK, we know briefly who the client is and their background but we did not deal directly with the client. We were told that we don't have to know about the client, but we have to understand the FRS" – Wahid, Offshore Project Manager, Bangladesh*

Because of incompleteness of the FRS, the offshore team had to make assumptions about the clients and their business process in order to envision the functions, processes and interface of the completed artifact. As explained by one of the Offshore Senior Developer:

*"There is no picture but just text in the functional requirement specification. I have to imagine how it will look, the users, type of communication required, their business and their basic knowledge. All the information is not in the functional requirement specification." – Offshore Senior Developer, Bangladesh*

In the process of sense-reading of the FRS, this developer has to imagine the users and their business to make sense of it. As indicated by Lowgren and Stolterman (2004), the operative image is important to bridge the vision to a specification. The offshore team did not share the designers' vision of the artifact and thus their assumptions made during programming of the functions, processes and user interface were often incorrect.

The UK designer's attempts at sense-giving into the FRS document draws on the prior knowledge that the designer in UK held about the client, users and business domain. The Bangladesh sense-reading of the FRS revealed that the UK designer's vision could not be easily

communicated to the Bangladesh team. Nazeer, the offshore team leader explains:

*"We used to make mistakes (during coding) quite often. It was for two reasons; first, we could not understand the client's requirement, and second, we could not understand the process (client's business process) as well." – Nazeer, Offshore Team Leader, Bangladesh*

Most of the communication between UK and Bangladesh involves dealing with problems with sensemaking of the FRS. One of the offshore team members stated:

*"We don't usually ask about technical things but more on understanding the requirements. Usually, we asked about the client. The UK office will provide information about what the client required for development purposes." - Offshore Senior Developer, Bangladesh*

The onshore teams stated that they attempted sense-giving by providing explanations about the requirements in as much detail as possible. This includes providing the link to the client's website. However, this was considered insufficient by the Bangladeshi staff to provide the necessary domain knowledge for sense-reading. Furthermore, the explanations about the project requirement were often ambiguous to the offshore teams due to the limits of their experience. Clara, the UK Director explains:

*"When we talk to the senior developer we notice that their knowledge and experience are very limited. We have to spend quite a lot of time explaining things to them." – Clara Director, UK*

According to Clara, the offshore team's lack of client domain knowledge was compounded by the technical knowledge background. The offshore teams' knowledge and experience were limited to the use of procedural language. Therefore the Bangladesh team could not fully understand the object-oriented language required for the project. According to Ahmed, the senior developer in Bangladesh:

*"When we joined Das, we were not familiar with Lotus Notes. We have to understand the life of the project and understand the processes and techniques by asking the senior developers and searching on the Internet. We didn't learn specific things in University but only learned basic programming." – Ahmed, Offshore Senior Developer, Bangladesh*

In addition to the prior knowledge, the process of sense making is problematic because of language ability and questioning behavior of the offshore team. On many occasions, the offshore team could not understand the explanations of the FRS given by UK developers due to language difficulty. One of the offshore team members explains:

*"English is quite tough for me and sometimes it is very hard to understand. In one situation, Clara tried to explain things but I didn't understand." – Offshore Senior Developer, Bangladesh*

This offshore senior developer had difficulty in interpreting the FRS due to his limitation in English. Besides the English language and accent problem, a further barrier to sensemaking was that the offshore teams "were not used to asking questions" (Clara). This is in contrast with the onshore teams who were regarded as asking questions "openly and freely". Interviewees in Bangladesh explained that they did not ask questions for three reasons: their "inexperience", "uncertainty" and they did not want to feel "discredited" for asking questions.

Failure to engage in questioning of the contents of the FRS meant that the offshore team was unable to complete effective sense-reading by affirming and checking the sense-giving in the FRS.

To overcome the sensemaking problems, new procedures and standards for were introduced. The process of sense-giving by the onshore team was improved by providing additional information about the client:

*"Clara describes the technical work clearly for the project so that we can visualize the whole project from the client's point of view." – Nizaar, Offshore Senior Developer, Bangladesh,*

This finding concurs with Yates and Orlikowski (1992) and Kouper (2010) on the use of documents that serve the purpose of communicating domain knowledge. Two new documents were required known as a Functional Work Through (FWT) along with a link to the client's website and the FRS and a Functional Technical Specification that included a detailed explanation of coding structures to meet client requirements in the FRS.

This greater level of prescriptive detail was important in facilitating imagination of the Bangladesh team so they could program in accordance with the designers vision of the required project output. Improved documentation process and standards were not the only reason for improved sensemaking. The offshore team improved their prior knowledge about typical client business processes as they gained experience in dealing with local clients in Bangladesh. As explained by an offshore team leader:

*"Before, we couldn't understand because we did not have experience. Now we can understand better because we also have experience in dealing with local clients." – Offshore Team Leader, Bangladesh*

Since Das (Bangladesh) started to serve local clients in Bangladesh in 2003, the offshore team gained experience in dealing with clients and became involved in the whole software development process, including requirement gathering, requirements analysis, systems design and FRS preparation. The offshore teams applied the process of software development, standards and procedures that they learned from local Bangladesh clients.

Another reason for sensemaking improvement is that most of the developers have now worked in excess of five years in Das and accumulated experience in understanding the FRS sent by the UK onshore teams. Over time, they improved their logical thinking and could predict the problems that will be encountered. According to the offshore project manager:

*"The thinking of logic on developing code has been improved. Before we write code, we will write pseudo code. We have developed the skills on foreseeing what the*

*problems will be when starting development." – Offshore Project Manager, Bangladesh*

The offshore teams have developed their technical and domain knowledge through their experience of handling Bangladesh clients and their experience in development work. When this is coupled with improved standards for sense giving from UK, the offshore team improved sense-reading of the knowledge being communicated to them and there were gradually fewer episodes of returned code not meeting client requirement. Lam (1997) explains that practical hands-on experience can improve an individual's tacit knowledge and, in this case, the experience over time of interaction with onshore teams and Bangladeshi clients has improved sensereading.

## V CONCLUSION

Empirical evidence from the case study shows that knowledge management in globally distributed software development team was hindered by the difficulties in performing sensemaking due to differences in their respective prior knowledge and cultural background. Lack of appropriate questioning behavior also resulted in incorrect sensereading. Such challenges could be overcome through details documentation experiences and cultural adaptation.

Theoretically, this study builds on extant literature on sensemaking and improves our understanding of the importance of aligning designer vision for effective sensemaking. It contributes an additional novel facet to the idea of sensemaking (Walsham 2004) explaining the importance of imagination for corresponding vision between onshore – offshore to emerge in offshore outsourcing (Lowgren and Stolterman 2004). The theoretical framework encapsulates challenges in sensemaking resulting from the differences in prior knowledge and cultural background of team members. This study also extends our understanding on cross-cultural issues in offshore software development with regard to questioning behavior in sensemaking.

Practically, prior work points to appropriate tools for representing knowledge in offshore software outsourcing. Findings here concur with Carmel and Tija (2005) on the importance of documents such as FRS including as many assumptions, descriptions and diagrams or flowcharts as possible. This paper improves our understanding of why this detail is needed and thus opens the 'black box' of what information should be included to align the designer vision. Another key contribution from this study is the insight that sensemaking is both an event and a process that can improve as learning takes place over time that allow all team members to experience the full lifecycle process of building up prior knowledge to enable a correspondence of vision.

This in-depth case study draws on a small software firm with offshore software development centre in Asia and the generalisation of the findings may be confined to the limited resources of such firms. Future studies may focus on larger firms and may obtain different issues that may influence the process of sensemaking.

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