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The Strategic Role of Remote Embedded Systems

Abstract

This thesis started with an ambition to match the business community's desire to obtain pragmatic data and a useful analysis with stringent academic demands. We used the theoretical framework of technological frames as well as theories around sensemaking to analyse the data obtained with interviews from ten managers in the same number of organizations. The managers were influential in the decisions made around the implementation of a specific type of system (remote embedded system), and our goal was to inquire into their perceptions of the strategic role of their remote embedded system. We found that three frames, or perceived strategic roles, were present among the respondents: rationalization, control and structural transformation. One of our interpretations indicates that there are few differences in the strategic roles between traditional systems and the examined remote embedded systems.

Keywords: Remote Embedded Systems,
Technological frames, Strategy

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Master thesis, 20 points

1 Introduction

This project started with an ambition to match the business community's desire to obtain pragmatic data and a useful analysis with stringent academic demands. Because of the relatively new technology or at least relatively new technology use, our journey towards the final goal has been exiting and interesting as well as, on occasion, a bit frustrating.

The technological alignment of our work revolves around telematic systems found in different vehicles, or rather similar to telematic systems but *not* used in vehicles. Although the actual technology used in such systems has been around for a while the real commercial breakthrough has been conspicuous by its absence. It seems to us that the explosive growth expected by many during the late nineties faded together with the rest of IT-business when the bubble burst in the beginning of this millennium. However, there are in fact some commercial applications that have been proven feasible, not the least some concepts employed by our principal company. To be sure, once again the market for these types of services is expected to grow rapidly in the years to come. Some reviewers even claim that a world market of more then 70 billion SEK by 2007 is possible (Larsson, 2002).

When new technology is introduced many people appear to see the technology itself as the revolution, forgetting about its use and neglecting its application in real world situations. In fact, Bill Gates (2002) meant that: *"most people tend to overestimate the advances technology will make in the next two to three years and to very grossly underestimate what will happen in the next 10."* In this thesis we will look at the uses of a fairly new technology and examine how different managers perceive its strategic role.

Behind the term "external principal" a large multinational industrial company is found. Their main focus is on the vehicle business and they develop, manufacture and market their products themselves. The task given to us by this external principal was to examine how business managers perceived the internal benefits (see below) of, what our clients called, telematic related systems, i.e. systems with some similarities to telematic systems. The company has been successful in marketing their telematic systems towards external customers, but, as they said themselves, have not done their homework when it comes to the internal use of their telematic infrastructure. Telematics is a conceptual term used to describe the utilization of information technology and wireless communication in vehicles. Indeed, one important property of telematic systems includes the use of *wireless* technology, thus enabling vehicles to utilize different wireless or mobile services.

As mentioned earlier, the main purpose of this study was to provide our external principal with an analysis of how companies in other lines of business (non-competitors) used telematic related systems in order to obtain internal benefits, a type of benchmarking approach actually. It was also considered interesting to find out how they estimated and created monetary value of their systems (Business Models) as well as how they created organizational support for their systems. Thus, the issues presented to us from the external principal were quite pragmatic and closely related to a wish to use the existing and future telematic infrastructure in order to obtain different internal benefits. Pretty soon we realized that these wishes were a bit too specific in order to properly fit into an academic context. The use of technologies related to telematics is quite new and our first scan of the academic literature didn't reveal any research related to these issues. This in conjunction with our wish to please our external principal in

giving a useful analysis made us go along with these issues. By then the academic perspective was still an open question. As a consequence we decided to author two different reports, one for our external principal with a more pragmatic and context specific content, and one with more academic and more general content. The data was collected in harmony with the issues imposed on us by our external principals. But as the collection of data was conducted in an open-ended manner with semi-structured interviews we still believe it's relevant to re-use the collected data to extract findings about a slightly different question, to be sure, this approach was utilized by Orlikowski and Gash (1994) in their important paper on technological frames (more about that later).

In order to understand the issues presented to us by our external principals it is important to mention a few terms or notions. Two expressions often mentioned in the discussions with our principals were *external* and *internal benefits* (see Table 1 for some examples). According to a study by Alshawi et al (2003), an *"outcome is the result of introducing a new IT system…"* while a *"…benefit is what is subsequently derived if the new capability is exploited"* (p. 419). Our own understanding of these notions is that external benefits are any benefit supplied by the company to their customers, and thus generating sales. Internal benefits, on the other hand, refer to the benefits from an (in this case) IT-system affecting the internal structures of the company, e.g. product development or efficiency promoting measures. Almost any kind of organizational or managerial improvements, in this case associated to an IT-system, can be related to internal benefits. It may include everything from organizational information management benefits to cost savings on printing paper. Very often it seams like these internal benefits are focused on cost savings as opposed to the external benefits, which are more focused on income generation (see Table 1 for some examples). Also, these notions are not always that distinct since internal benefits very often provide the external customer a certain amount of benefit and vice versa. For the purpose of this thesis these concepts are not as central as they were in the report to our principals, but we still wanted to mention this for the sake of clarity.

Since we weren't to look directly into their competitors' telematic systems we directed our attention towards similar systems outside the transportation and vehicle manufacturing business. To be able to draw feasible conclusions we wanted to look at systems with a strong resemblance to these telematic systems used in the vehicle industry. In our report we have used the term *remote embedded systems* (RES) to designate these types of telematic related systems.

It seams to us that the scientific landscape concerning this specific type of systems is largely unexplored. We haven't found much literature related to this specific research domain. Some literature concerning embedded systems was found, but that was mainly of technological nature. Thus, our intention with this thesis is to start filling up this possible gap with our own humble contribution.

The data acquired in order to shed some light onto the issues presented to us by our external principals did not only show how the respondents' organizations used telematic related systems (or RES) in order to obtain internal benefits, but as we'll later argue, also reflected their view of the strategic role of such a system.

Internal Benefits	External benefits
Cost savings	*Income generation*
Increased efficiency	*Customer benefits*
Organizational development	*Gaining competitive advantages*

Table 1, some examples of internal and external benefits

1.1 Purpose and Issue

The purpose of our work has been to shed some light onto the motives and drivers behind an implementation of what we call remote embedded systems. We are interested in how managers perceive the strategic role and the strategic motive for a specific type of IT-system. In order to accomplish this we decided to approach managers in an array of organizations. Our research question is: *How do managers perceive the strategic role of remote embedded systems in organizations?* In order to answer this question a bit more concrete sub-question could be: What is/was the reason to implement this new technology?

1.2 Delimitation

The one most important delimitation is that we haven't inquired about any external factors, such as customer benefits or competitive advantages, because our original mission didn't include this perspective. Obviously the mission imposed to us by our external principals is a quite significant delimitation by itself. In relation to our research question the most important delimitation is our lack of painstaking technical descriptions of the investigated systems. Another important delimitation is the fact that we just interviewed Swedish managers from Swedish companies, thus effectively eliminating any cultural aspects of the survey. Finally, we have just interviewed companies with more than 200 employees, thus excluding any input from small companies.

1.3 Disposition

The rest of our report has the following disposition: *Chapter 2* describes the theory were we'll account for the theoretical frameworks used to structure our thesis. *Chapter 3* describes embedded systems and remote embedded systems and we try to give a valid definition of these systems. *Chapter 4* describes our method. We will describe our course of action and the method used during our study. *Chapter 5* gives an account of the empirical findings from our interviews. *Chapter 6* accounts for the discussions around our findings, and finally *chapter 7* concludes the key findings in this work.

2 Theory

In this chapter we will account for the theoretical frameworks used to structure our findings. The two main tracks in our thesis are “sensemaking” (relying heavily on the thoughts of Karl Weick, e.g. 1995) and “technological frames” (relying greatly on the work of Orlikowski and Gash, 1994). These main concepts are closely related. To make it a bit simple, sensemaking is the broader perspective, whereas the technological frames concept is a more concrete application, further related to sensemaking processes in a context including IT artifacts.

In this case, the notion of sensemaking concerns how people resolve uncertainty and ambiguity in organizational structures (Weick, 1995), it’s about “…placement of items into a framework, comprehending, redressing surprise, constructing meaning, interacting in pursuit of mutual understanding, and patterning” (p. 6). The notion of technological frames relies heavily on the work conducted by Orlikowski and Gash which is reflected in the article: “Technological Frames: Making Sense of Information Technology in Organizations” (1994). The purpose of the article was to present a conceptual framework which can be used to explain and anticipate actions and meanings. They claim that by knowing the technological frames of key groups one could predict if problems are likely to evolve. If the technological frames of key groups differ, the likelihood of distorted development and use is rather high. The following account is, obviously, largely following the theoretical part of this article. If the concept of technological frames is a more specialized way of approaching the domain of perceptions and meanings when studying different IT artifacts, we will regard sensemaking as being a more general concept, somewhat of a super class to technological frames if you will (see Figure 1 below).

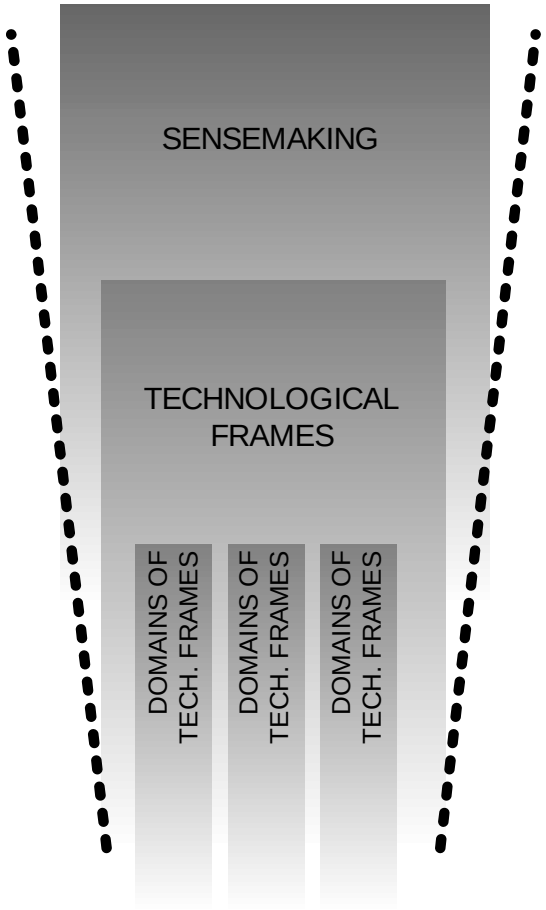

Figure 1, Schematic representation of the relations between technological frames and sensemaking

2.1 Sensemaking

Sensemaking is about the internal process of organizing perceptions, interpreting them and acting (physically and/or mentally) according to those interpretations. In other words: making sense of your environment. When, for instance, humans face a new IT-artifact, trying to understand it, they engage in a sensemaking process. Making sense of technology is vital for people in order for them to interact with it (Weick, 1995). The sense-making process itself tends to develop particular assumptions, expectations and knowledge of the technology.

The concept of sensemaking has been described as "interpretation coupled with action" (e.g. Gioia et al, 1994; Weick, 1995) and consequently, reflects the combination of thought processes with execution of that thought. Sometimes sensemaking may be confused with interpretation, and as just stated there is a strong connection of the two. But the key distinction, as Weick (1995 p. 13) puts it, "is that sensemaking is about the ways people generate what they interpret." To further clarify he states that sensemaking *is* a process while interpretation may be a process but may just as well be a result. He also means that sensemaking focuses on the invention that precedes the interpretation.

The links between Sensemaking and technological frames are more than obvious. But while the concept of technological frames, to a great extent, springs from the notion of sensemaking, relates it to IT artifacts and uses the framework for a more concrete application, the sensemaking perspective is more about how to acquire knowledge about

these processes. Consequently we find it interesting and useful to penetrate that particular theory, or maybe that particular perspective, a bit more thoroughly.

Waterman (1990) means that sensemaking is about structuring the unknown while some describes it as the placing of stimuli into a mental framework (e.g. Dunbar 1981). Another explanation of what Sensemaking is about is given by Rex E. Pereira (2002): "*Sensemaking is defined as the cyclical process of taking action, extracting information from stimuli resulting from that action, and incorporating information and stimuli from that action into the mental frameworks that guide further action"* (p. 40). And Thomas et al. (1993) means that sensemaking is "*…the reciprocal interaction of information seeking, meaning ascription, and action*" (p. 240).

Karl Weick (1995) argues that the way people organize themselves, how they resolve uncertainty and ambiguity, and discover meaning is controllable. Sensemaking refers to how meaning is constructed at both the individual and the group levels. Through the construction of meaning, clarity increases and confusion decreases which leads to higher productivity, better quality, and greater confidence in group-processes (Weick 1995). In Ola Henfridsson's (1999) doctoral thesis he describes sensemaking from an IT-perspective as a process through which people construct a meaningful way to use IT artifacts. He means that the process is triggered by, and partly dependent on, the particular IT-artifact itself.

These definitions and explanations of sensemaking provide a (hopefully) useful background in order to grasp the concept of sensemaking and to gain an initial understanding. Next we will account for Weick's (1995) seven properties of sensemaking and incorporate some implications of an application of these thoughts on IT-systems made by Pereira (2002) and Seligman (1999).

Sensemaking is grounded in identity construction

"People learn about their identities by projecting them into the environment and observing the consequences." (Weick, 1995 p. 23) This means that people learn who they are by acting and by reflecting upon those actions, but also by the actions, or rather the reactions, among those around him or her. Seligman (1999) and Pereira (2002) means that IT adoption have a rather direct impact on identity construction, implicating that a arbitrary technology user may consider himself as belonging to a certain personality category (such as: cutting edge, intelligent, nerdy, professional etc.) depending on whether he or she has adopted that technology or not

Sensemaking is retrospective

This means that people can only make sense of what has already happened. An implication of retrospective sensemaking is that adoption attitudes are formed by passed adoption experiences (Seligman, 1999; Pereira, 2002).

Sensemaking is enactive of sensible environments

This means that a person participates in the evolution of her environment and then must make sense of environmental events that result in part from her participation, i.e. people are a part of their own environments (Weick, 1995). One IT-related implication of enactment may be that if the user does not enter data into an information system correctly and timely, the system may fail to live up to her expectations and the adoption process may suffer (Seligman, 1999; Pereira, 2002).

Sensemaking is social

Sensemaking is social because each person obtains sense in part from the words and actions of others, and produces sensible actions and discussions that add to the sensemaking of others (Seligman, 1999; Pereira, 2002). Weick (1995) means that sensemaking is never solitary because what a person does internally is dependent on others. Or as Weick (1995, p. 39) puts it: *"Conduct is contingent on the conduct of others, whether those others are imagined or physically present."* For example, after a group discussion a member's opinion may not reflect the entire groups' but his mental framework incorporates stimuli from the other members of the group. Each individual interacts with her social environment and develops her mental models based on the information cues extracted from those interactions (Seligman, 1999; Pereira, 2002).

Sensemaking is ongoing

The cyclical nature of the sensemaking process means that it is ongoing. A person acts, makes sense of her actions, and then acts again, this time guided by the sense that he or she has already made. Or as Weick (1995), more exactly, puts it (p. 43): *"Sensemaking never starts. The reason it never starts is that pure duration never stops."* For example, the results and experiences of a user's first attempt to use a technology are part of the basis by which the user will decide whether or not to make a second attempt. Over time, continued use of a system affects the user's level of expertise with the system and the compatibility of the system with the user's other duties. This view is supported by structuration theory, which suggests that a technology can "condition" the practices of its users by facilitating and constraining user actions (Orlikowski and Robey, 1991).

Sensemaking is focused on and by extracted cues

Extracting cues is the process of noticing what is relevant and useful to mentally represent stimuli, and contributes to both the maintenance and evolution of mental frameworks (Seligman, 1999; Pereira, 2002). Weick (1995, p. 50) means that extracted cues *"…are simple, familiar structures that are seeds from which people develop a larger sense of what may be occurring."* Some important characteristics of cues (Seligman, 1999; Pereira, 2002) include that they are received as perceptions and, therefore, with subjectivity, furthermore there is no reason to assume that everyone that experience the same event will pick up the same cues. There is also considered that control over cues is a source of influence and power (Smirchich and Morgan, 1982). Another important implication is that anyone who provides cues to an information system must have some skill in knowing what cues to provide, if failing to do this the systems usefulness and adoption may suffer (Seligman, 1999; Pereira, 2002).

Sensemaking is driven by plausibility rather than accuracy

Weick (1995, p. 62) summarizes this property with the phrase: *"I need to know enough about what I think to get on with my projects, but no more, which means sufficiency and plausibility take precedence over accuracy"*. Sense is not only an understanding of what is directly observable and accurate, but also the achievement of a level of reasonableness for a situation that is suitable for the sensemaker's needs. This "plausible reasoning," as Isenberg (1986) notes, exists even if the sensemaker has an incomplete or inaccurate understanding of the facts. Furthermore, plausibility is the result of preferential consideration of, and belief in, information. Weick (1995) quotes Fiske's statement that sensemaking *"takes a relative approach to truth, predicting that people will believe what can account for sensory experience but also what is*

interesting, attractive, emotionally appealing, and goal relevant" (Fiske 1992, p. 879). The consequential sense is a kind of preferential plausibility that frames stimuli so that the preferences of the sensemaker are addressed (Seligman, 1999; Pereira, 2002). In other words: sensemaking is highly subjective.

For example, if a person was asked on a seven-point scale the extent to which he believed that his next automobile trip would involve a collision, he would likely pick the choice for least belief based upon his experience. However, he may adopt seat belt technology because he thinks that a collision could happen, and avoiding injury in the event of a collision is a strong preference of his (Seligman, 1999). Or expressed in a more informal, plain way: better safe, than sorry. According to Seligman (1999) This distinction is important because many constructs in existing acceptance models incorporate beliefs about what would happen, not what could happen (e.g., Davis', 1989, perceived usefulness and perceived ease of use constructs).

These properties provide a useful structure in order to assess and interpret the empiric material described later in this thesis.

2.2 Frames

The notion of "frames of reference" emanate from social cognitive research which, among other things, is about how peoples interpretations of the world affect the way they act and how they provide the social reality with meaning (Berger et al 1967, Smircich et al 1985, Weick 1979a in Orlikowski and Gash 1994). An individual's frame of reference has been described as a collection of tacit knowledge that is used to entail structure and meaning to ambiguous social and situational information in order to aid understanding (Gioia, 1986). In an article by Orlikowski and Gash (1994) they propose a conceptual framework that can be used to explain and anticipate actions and meanings that, according to the authors, is not easily obtained with other theoretical perspectives. This framework will, later, constitute the basis on which our analysis will be built. The concept of frames seems rather wide-ranging and although Orlikowski and Gash (1994) acknowledge the fact that the term "frame" has a wider meaning they here adopt it as *"… how organizational members make sense of and assign meaning to their environment, organization, and tasks."* Furthermore the notion of frames is said to include assumptions, knowledge, and expectations. They are expressed symbolically through both visual and textual language and can have both constraining and facilitating effects (Gioia, 1986). To sum up Orlikowski and Gash (1994) states that *"… frames of reference offer a crisp and powerful lens for focusing specifically on how people make sense of particular aspects of the world."*

Continuing the reference to social cognitive research there is said that while members of a group have individual interpretations, they also have a set of core beliefs in common (Porac et al, 1989). Orlikowski and Gash (1994) means that while frames are individual cognitive structures or mental models, they are also: *"… assumed to be shared by a number of individuals when there is a significant overlap of cognitive categories and content."* Or as some researchers suggests, people tend to share assumptions, knowledge and expectations with their fellow workmates (e.g. Gregory, 1983). When combining the last two statements, we hope it's not too bold to conclude that shared frames in workgroups are quite frequent. Finally Orlikowski and Gash (1994) view of shared frames is that *"… individuals can be said to share a frame if some core cognitive elements (assumptions, knowledge, an expectations) are similar"*.

2.3 Technological frames

The notion of technological frames concerns individual and shared frames of reference toward technological artifacts, in this case information technology artifacts. Orlikowski and Gash (1994) use the term to *"…identify that subset of members' organizational frames that concern the assumptions, expectations, and knowledge they use to understand technology in organizations. This includes not only the nature and role of the technology itself, but the specific conditions, applications and consequences of that technology in particular contexts."* (p. 178). Orlikowski and Gash (1994, p. 199) later define technological frames: *"…as the core set of assumptions, expectations, and knowledge of technology collectively held by a group or community. While technological frames are individually held, they are also social phenomena, in that mutual understanding shared by individuals undergrids enactment of a social reality."* In other words, technological frames are about how organizational members believe a particular IT-artifact is affecting them in one way or another.

Bijker (1995) sees technological frames as *"a theoretical concept… used by the analyst to order data and to facilitate the interpretation of the interaction within a relevant social group"*. The focus of Orlikowski and Gash (1994) research on technological frames is on their social nature, their specific content and their implications for technology development, implementation and use. Furthermore Orlikowski and Gash (1994) states that because *"…technologies are social artifacts, their material form and function will embody their sponsors' and developers' objectives, values, interests, and knowledge of that technology."* In other words, since technology projects (in our case IT-projects) are owned by managers and carried out by developers that (in most cases) are humans, they impose their human standards, values and unconscious intentions onto the developed system. Views of what the division of labor should be, how work should be done, how much autonomy employees should have are all examples of assumptions that are consciously or implicitly built into IT by system planners and designers (Orlikowski, 1992a). Furthermore, there exists evidence showing that these imposed intentions don't play an exclusive role in defining the future role of the technology. In fact, it seems like the intended fit seldom is entirely accomplished. The properties or characteristics imposed onto the systems by developers constitute the foundation from which the users define the technology by attaching and detaching different meanings over time. (Henfridsson,1999).

2.3.1 Congruence of frames

Congruence of technological frames concerns the fit between different key groups' frames of reference. Usually there are a number of important social groups whose actions will affect the process and outcome of technological change. When, for instance, referring to IT efforts, developers, managers and users are obvious groups (Orlikowski and Gash, 1994).

These group frames are unlikely to be shared across the different stakeholders groups (Calder and Schurr, 1981). For example, developers and IT-personnel may or may not have a more technological view of the system then other groups (Orlikowski, 1988). Managers, on the other hand, may be more prone to have a strategic understanding of technology, expecting it to aid certain ways of doing business and providing financial returns, while users may take a more focused (instrumental) view expecting immediate, local, and task-specific benefits.

Orlikowski and Gash (1994) defines the notion of congruence in technological frames *"…as referring to the alignment of frames on key elements or categories. By congruent, we do not mean identical, but related in structure (i.e. common categories of frames) and content (i.e. similar values on the common categories)."* This, for instance, could imply similar expectations around the role of technology in business processes, the nature of technological use, or the type and frequency of support and maintenance.

Incongruence, on the other hand, implies vital differences in expectations, assumptions, or knowledge about some key aspects of the technology. This may, for instance, become apparent when managers believe that a technology will change the way their company does business, while the users suppose the technology is intended to merely speed up and control their work. Orlikowski and Gash (1994) concludes that they *"…expect that where incongruent technological frames exist, organizations are likely experience difficulties and conflicts around developing, implementing, and using technologies."*

One critique against using technological frames is brought forward by Ola Henfridsson (1999, p. 29), as he believes that *"…the concept is a bit too narrow to capture the whole range of complexity"*. He means that the way technological frames are affected and cultivated through interaction with IT-artifacts as well as how the frames actually got there is not thoroughly accounted for.

2.3.2 Original application of Technological Frames

When applied to a context of a consulting firm implementing a groupware technology, Orlikowski and Gash (1994) uses three domains of technological frames (nature of technology, technology strategy, and technology in use). Orlikowski and Gash (1994) came up with these domains by means of a quite inductive method, using the collected data to derive categories and themes, rather then taking their starting point from existing literature. The study focused on a five-month period, during the implementation phase of a groupware system. They used a qualitative method, making 90 unstructured interviews with both technologists and users. They also carried out field observations and reviewed documents of different kinds. The content analysis of the data was carried out in a way that suggested groups from the data itself rather than imposed from outside (e.g. Agar, 1980). A cross-group analysis revealed common themes and by re-examining and recoding the data they came up with a set of themes and categories that later became the three domains discussed earlier. These domains were then inspected for similarities and differences across functions and the greatest differences were present between technologists and users. The three domains were:

- *Nature of technology*: Refers to people's image of the technology and their understanding of its capabilities and functionality.
- *Technology strategy:* Concerns people's view of why their organization acquired and implemented the technology, including their understanding of the motivation or vision behind the adaptation decision and its likely value to the organization.
- *Technology in use:* Refers to peoples' understanding of how the technology will be used on a day-to-day basis and the conditions and consequences associated with such use.

The authors mean that these domains are quite general and are likely to fit a variety of contexts and situations. Furthermore they state that *"…much will be learned by*

examining them [the domains] in other organizational contexts and with other technologies" (p. 201). Another example of application comes from Lin and Cronford (2000) that use the notion of technological frames in a case study of the early stages of a new e-mail system in an international banking institution. To fit their data and their environment they have used another set of domains than Orlikowski and Gash (1994). Their data suggested four domains:

- *The nature of problems:* understandings of organizational problems in relation to technology.
- *Requirements for the system:* positive expectations of the technology in organizational terms.
- *Images of implementation:* understandings of the process of change that brings technology into the organization.
- *Issues of use:* concerns about technology in use and impact on work activities.

2.3.3 Application of theory

Initially technological frames were applied to the context of case studies. The originators behind this concept, Orikowski and Gash (1994), applied the framework to one organization (a consulting firm called Alpha), to one system (Lotus Notes), considered multiple groups or units of analysis (Technicians and Users) and studied their objects over an extended timeframe (about five months). The focus for our thesis has been somewhat different (see Figure 2, below). We wanted to examine the *managers'* technological frames around remote embedded systems (RES). We studied multiple organizations (eleven) one group of respondents (managers) and multiple but similar systems (eleven RES). Accordingly, the common denominator in our study has been the respondents' position, i.e. managers or IT decision makers, and the similarity of the systems. The benefits of our approach are basically related to generalization. We believe, and hope, that it is possible to say something about the prevalence of different opinions within specific domains of technological frames, in more universal terms.

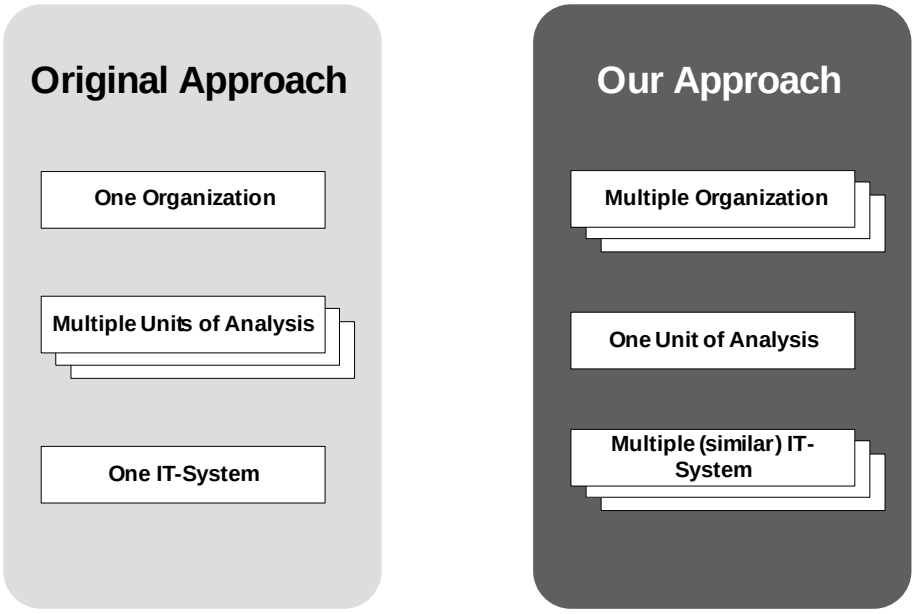

Figure 2, Our approach compared to Orikowski and Gash's (1994) original apporach

In the theoretical framework of technological frames developed by Orlikowski and Gash (1994) the notion of "congruence of frames" is a key component (see above). It concerns the fit between different key-groups' frames of reference and they mean that incongruence between key groups is a common reason for unsuccessful IT-efforts. Since we only examined one group (managers), it's hazardous for us to say anything about this. However, we will use this existing notion when presenting our discussion.

2.4 Why sensemaking and technological frames?

The use of sensemaking and of technological frames wasn't evident to us from the beginning. It was not until our data was collected and our analysis were about to start we discovered these concepts. The notion of technological frames were introduced to us by our academic supervisor Ph. D. Rikard Lindgren and after studying a number of articles we realized it may be possible to use technological frames as well as the theories about sensemaking. One very appealing fact that contributed to our decision was that Orlikowski and Gash (1994) actually used technological frames on old data collected *before* the theories were developed, just like we did.

3 RES

To better grasp the notion of embedded systems we will begin with a brief description of embedded systems and place them into a more holistic context. Furthermore we will define embedded systems based on the existing scientific literature and, finally, explore the unique characteristics of the investigated systems and relate this to the definition of embedded systems. Once again we want to emphasize our center of gravity is not technology but rather functionality.

3.1 Embedded systems

Historically four evolutional eras can be recognized in the domain of information technology. The *first* era began somewhere around 1950. Characteristic for this period was that each application was custom designed for a specific purpose and without any ambition of mass production. During the *second* era, in the sixties, the use of databases evolved and multi-user systems were introduced. Throughout this period mass production also became more frequent. The concepts of real-time systems, i.e. systems used to collect, analyze, and transform data from several sources, also began to advance during this period. Maybe the most important innovation during the *third* era, beginning around the middle of 1970, was the microprocessor. The introduction of the microprocessor marked the start of a new stage of intelligent products both in the industrial and in the consumer markets. As a consequence of this, embedded system was introduced. Distributed systems, lower cost hardware, consumer impact and the birth of the Personal Computer (PC) were also important events during this era. The *fourth* and (probably) current era of computer system evolution begun in the mid-eighties. Some characteristic elements during this era were the introduction of powerful desktop systems, object-orientated technologies and expert systems. The evolution of a worldwide information network provided a new way of working, and people could easy get information all around the world.

Trying to define the examined systems is a bit complex, it's not as easy as dubbing them DDS[1], ERP[2] or CSCW[3] systems. There are several types of IT systems; each category has its own set of characteristics and technologies. There are systems like Management Information Systems (MIS) that typically access several large databases containing different business information or there are systems used to facilitate different decisions throughout an organization. Another category, in some ways related to our investigated systems, are the Real-Time systems that monitor, analyze or control real world events with minimal time-delays. A real-time system is any information processing system, which has to respond to externally generated input stimuli within a finite and specified period. They are used for such tasks as navigation, in which the computer must react to a steady flow of new information without interruption. Most general-purpose operating systems are not real-time because they may use a few seconds, or even minutes, to react. Real-time can also refer to events simulated by a computer at the same speed that they would occur in real life. Some of the investigated systems in our study can be said to cohere to the notion of real-time systems.

[1] DSS, Decision Support System

[2] ERP, Enterprise Resource Planning

[3] CSCW, Computer Supported Collaborative Work

As mentioned earlier we conducted interviews at ten companies, and a total of eleven systems have been analyzed. The already existing category closest resembling the eleven systems seems to be the so-called *embedded systems* and some also bear a strong resemblance to real-time systems.

The uses of embedded systems include a rather broad range of applications, from household appliances via automotive electronics to safety critical systems. They can be found in a variety of products ranging from cars and trucks over cellular phones, cameras, lifts, traffic lights, car park barriers, heating and air conditioning system etc. Embedded system are also used in larger scale operations, from offshore oil rigs to gas pipelines, from electricity transmission to water plants, from navigating oil tankers to controlling traffic (Kippenberger, 1999). Compared to, for instance, PC-based systems, embedded systems are generally less flexible; rather, they are highly engineered to perform their intended function optimally (Williams, 1999).

3.1.1 Definition of embedded system

Trying to define embedded systems is not an altogether uncomplicated task. On a functional level it can be said that "…embedded systems can be used to control, monitor or assist the operation of equipment, machinery or plants, 'embedded' signifying that they are an integrated part of that equipment." (Kippenberger, 1999) A Simple, more technological, definition is: "the use of programmable processors in application-specific systems" (Wolf, 2000). Pressman (1997) also uses the limited functionality as a characteristic property: "Embedded systems can perform very limited and esoteric functions (e.g. key pad control for a microwave oven) or provide significant function and control capability…" For the purposes of this thesis an adaptation of these definitions is adopted: *"An embedded system is any device used to control, monitor or assist the operation of some equipment or machinery and is an integrated part of that. It combines hardware and software and includes one or more microprocessors for a specific application."* However, dubbing our studied systems as embedded ones might not be exhaustive enough. Each of the investigated eleven systems has some kind of remote sensor and the characteristics for embedded system do not include this as a requisite.

3.1.2 Characteristics of the Investigated Systems

In order to define or classify the investigated systems we will try to extract and describe the unique features and characteristics of these eleven systems. This will later result in a definition reflecting the features of the systems inquired into.

Using embedded systems as a starting point, our definition stipulates that monitoring, control and/or assistance is characteristic attributes for these types of systems. The investigated systems were all used to monitor some aspects of the environment. These monitoring activities used sensors to indicate tank-levels, vibrations, geographical position etc. A majority of the investigated systems were also equipped with control capabilities, implicating the possibility to affect the equipment in some way (turning functions on or off, increasing/decreasing different parameters).

Another property complying with the definition of embedded systems is that the hardware of the investigated systems (including different sensors) used for monitoring and control are an integrated part ("embedded" if you will) of some equipment (gas-tanks, busses, ventilation systems, etc.).

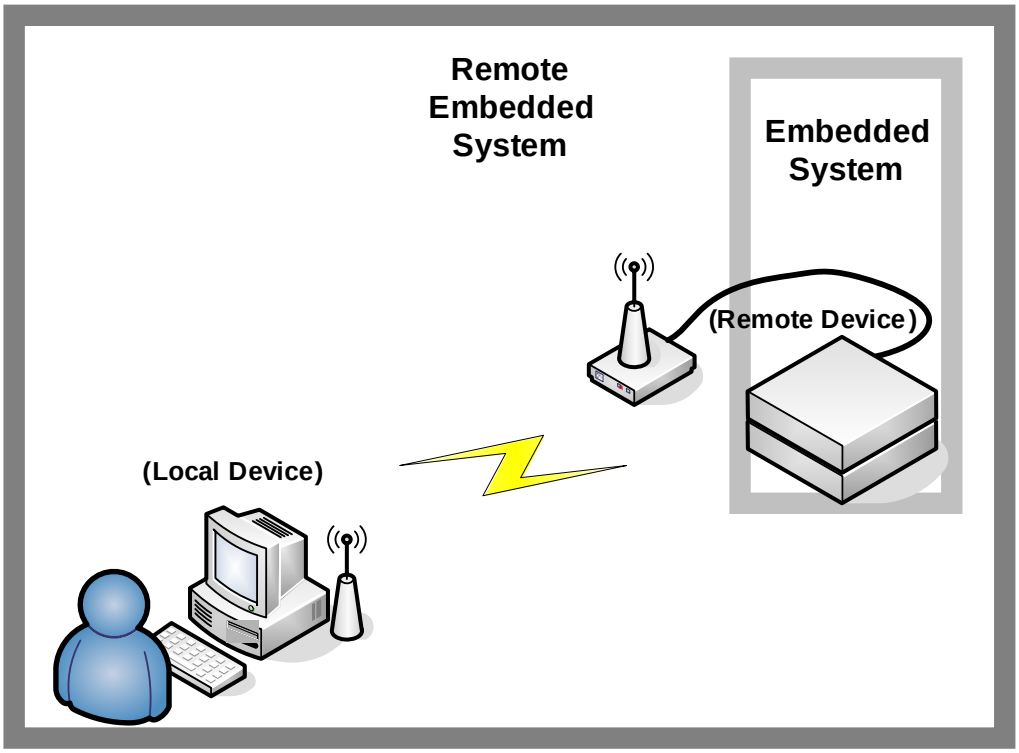

Figure 3, Embedded system in relation to RES

However, the systems in our survey did not comprise of embedded system alone. All systems also used a more traditional platform, or sub-system (often a PC) as a device used to cultivate or refine the raw data flowing from the embedded systems. This implicates that the embedded system is remote, i.e. there is an arbitrary physical distance between the sub-system used to cultivate the data and the embedded system used for data acquisition. The technology used to transfer data between these remote and local systems often falls into the category of wireless communication (GSM, GPRS, WLAN, etc.). It is important to note that the transfer technology has not been a requisite when selecting systems to investigate, since the significance of this is negligible. There is no great difference in organizational behaviour patterns if data is transferred through land based copper cables or through wireless networks compliant with the latest 801.11b standards.

3.2 Definition of RES

According to the definition of embedded systems above, the systems we have examined are in fact embedded systems, but are that exhaustive enough? We have decided to use technological features as the basis for our definition. The eleven systems, which have been analyzed, are not strictly embedded systems. As you can read above all systems have some kind of remote sensors. But apart from including remote sensing the systems are quite similar to the definition of embedded system given above.

Sensors

The examined systems include at least one remote device (the sensor) and one local device (the main system). Typically the remote device sends data to a local device/computer that processes the data in order to generate information. In most

examined systems the local device/computer are also capable of sending instructions *to* the remote device, e.g. for manipulating a parameter in a machine, or the like.

Distance
There is an arbitrary distance between remote and local device. Typically the systems utilize wireless technology for communication between remote and local devices.

Our definition is as follows: *"A Remote Embedded System (RES) includes, at least, one remote device and one local device. The remote device is an embedded system that initiates and/or reacts to some event and is capable of receiving and/or sending data to/from the local device which also is used to process the data into meaningful information."*

4 Method

The method used when conducting a survey or a study is quite crucial in order to interpret the result. The reason to use and account for a methodology is to enable replication of the study and to facilitate a critical assessment of the result (Backman, 1998). In our case the study is wide-ranging rather then penetrating. We have adopted a more hermeneutic or qualitative approach that, among other things, implies that the observer interacts with the subject and therefore overthrows the possibility for an objective un-biased examination (Backman 1998, Easterby-Smith 2002). These obviously make it impossible, or at least very hard, to exactly replicate a qualitative study. But in spite of this, the description of the method used is still crucial to the reader in order to assess the validity and reliability of the study. Maybe it is even more important with a painstaking account of the methodology in qualitative studies *because* of the difficulty to replicate.

The qualitative methods are characterized by the use of verbally formulated results (Backman, 1998). Two examples of qualitative methods are open-ended interviews and observations. The purpose of using qualitative methods is to explain why and how different types of phenomenon arise. The starting-point of qualitative methods is related to a more natural method of gathering data, something that constitutes a more appropriate foundation for examining human behavior. The most important drawbacks include the level of experience and skill needed to interpret and analyze the result as well as the time-consuming nature of qualitative methods (Easterby-Smith et al 2002). In spite of our inexperience, the use of qualitative methods seemed appropriate for our purposes.

In general, most positivistic research projects primarily use quantitative methods whereas the relativistic research project typically utilizes qualitative methods. Although being a coarse simplification this illustrates the consequence of deciding upon what research philosophy to adopt. For that reason we will briefly discuss some basics of research philosophy in the following section.

4.1 Research Philosophy

The adopted research philosophy is of great importance and influences the whole process. In this section we try to briefly describe the two major philosophies.

In the world of social science there can be said to exist two contrasting views of how research should be carried out. The first is the positivistic research philosophy and the other is the hermeneutic or relativistic research philosophy. The positivistic philosophy stems from the thoughts and theories of French scientist and philosopher Réne Descartes (1596-1650) and was later encapsulated and transformed into the positivistic research philosophy by another French philosopher, Auguste Comte (1798-1857) (Dahlbom et al, 1993). He cherished the natural sciences and wanted to apply these thoughts on the social sciences (not yet developed).

The hermeneutic or, as Dahlbom et al (1993) puts it, romantic research philosophy, on the other hand, originated from the interest in studying art and history. There were no correct answers but rather different perspectives from which the research could be observed. Texts, artworks and history were studied and interpreted and were later formulated into a research philosophy called relativism and hermeneutics (Dahlbom et al, 1993).

Other terms indicating hermeneutic philosophies, or maybe special cases of hermeneutic philosophies, used by some researchers are *"qualitative perspective"* (e.g Backman 1998) and *"social constructionism"* (e.g. Easterby-Smith et al 2002). Opposed to the objective view of reality proposed by the traditional perspective, the qualitative perspective regards reality as an individual, social and cultural construction (Backman 1998). While the traditional perspective separate the individual from the environment as a means to observe it as objective as possible, the qualitative perspective acknowledge the observer and place her in the, now, subjective environment. The qualitative perspective typically inquires into how the individual interprets and shapes his own environment. In the qualitative perspective it is important how people perceives, interprets and structure the surrounding reality in relation to his or hers own knowledge.

According to Easterby-Smith et al (2002) social constructionism is an approach stemming from the work of Habermas (1970) referred to as interpretive methods. The work of the social constructionist researcher should be about appreciating the different constructions and meanings that people place upon their experience. Easterby-Smith et al (2002) means that the aims of a social constructionist researcher are to understand *"…how people invent structures to help them make sense of what is going on around them"* (p.34).

The qualitative perspective is generating, rather than evaluating, hypothesis and thus inductive rather than deductive (Backman 1998). In the same manner Easterby, Smith et al (2002) means that research progress (for a social constructionist) is accomplished by the gathering of rich data from which ideas are induced.

4.2 Course of Action

Our course of action relies quite heavily on Backman's (1998) proposed research process for the qualitative perspective. However, similarities to Easterby-Smith et al (2002) view of social constructionist research philosophies will be highlighted as well as an adaptation to Orlikowski and Gash's (1994) framework of technological frames will be made. Below you will find a model of our course of action (Figure 4). This model is adapted from the figure illustrating the qualitative research process found in Backman (1998, p. 50).

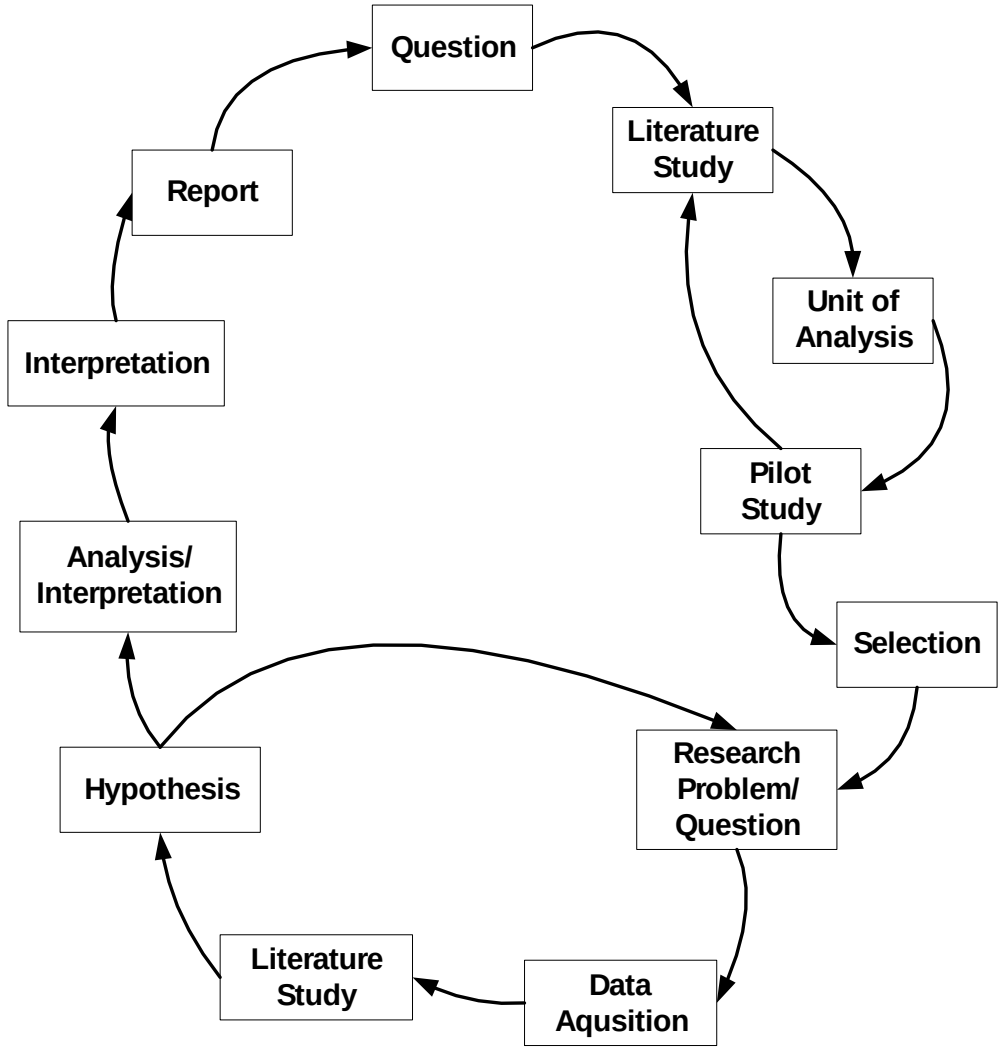

Figure 4. Our course of action (adapted from: Backman 1998)

4.2.1 Literature study

The goal of our literature study was to create a landscape in which our study would reside. The choice of scientific perspective best fitting the objectives of this thesis has mainly been the notion of sensemaking (e.g. Weick 1995) and the concept of technological frames[4] (e.g. Orlikowski and Gash 1994). The methodological literature leans towards the interpretative or hermeneutic research perspective, although more positivistic text has been penetrated as well. In order to define the technological properties of our studied systems our focus has primarily been on embedded systems and, to some extent, real-time systems.

The initial literature was related to methodological matters concerning the future path of our work. The design of our study as well as selection procedures and interviewing techniques are examples of topics in which knowledge was gained. We also studied different text-material in order to define and frame the investigated type of systems,

[4] Thanks to Ph. D. Rikard Lindgren for his suggestions on this matter

later dubbed as remote embedded systems (RES). However, the major part of our literature study was conducted *after* the data was acquired, i.e. after the interviews. This chunk of our literature study was aimed at forming the theoretical backdrop of our data to structure our findings. Furthermore, the theories may also be important in order to generalize the results (Yin 1993). As evident, we have adopted an approach in our literature study to *not* read too much before the data has been acquired. This approach is quite common in qualitative studies and the motive of this is to not influence the researcher too much before the data is collected (Backman, 1998).

4.2.2 Pilot Study

In order to educate us further in the domain of our investigated systems we conducted a pilot-study at a company that specializes in developing embedded systems and machine-to-machine (M2M) technology such as wireless monitoring and control. The main-purpose of the pilot-study was to get input for the execution of the survey in our main study. Another important reason for our pilot study was to get suggestions on organizations that use embedded systems and M2M technology in their business, but we also wanted to get a feel for what organizational category the respondents were to be a part of (i.e. managers, end-users, etc.). While not being an overwhelmingly significant motive for our pilot study, we also took the opportunity to test some technical aids we wanted to us during our main study.

4.2.3 Unit of analysis

During this stage we tried to identify our unit of analysis more explicitly, thus effectively delimiting our research domain. Since our preliminary question included the managerial perspective as well as a quite clear definition of the type of systems to be investigated, this stage was not really overly gruelling. Thus our unit of analysis was: *managers with a historical or current mandate to decide on whether a remote embedded system was to be implemented or not (or at least have a clear insight in the process).*

4.2.4 Company search / Selection process

After the pilot-study we began to gather information about interesting companies that used remote embedded systems (RES) in their businesses. The information was collected in several ways, through the Internet, through newspapers, through the yellow pages as well as through suggestions from our supervisor and from our pilot-study at company C0. This resulted in about fifty interesting companies (see Figure 5). The actual selection-phase began by trying to contact the companies to find out if they had any RES and, if they had, to find the right person to talk to. Consequently, this process took up more time than we expected mainly due to the novelty of the technology and problems matching our agenda with the respondents. Since our study doesn't have a technical angel the person we were looking for were more likely to work with business development then engineering. After contacting the companies it became clear to us that it was hard to find companies that used RES and, if they did, to find the right person to interview. When finished, the list was narrowed down to ten companies in and around Gothenburg and Stockholm (Sweden) with computer systems associated to RES. All these companies were booked. Some companies like ABB, would have been very interesting to visit but had to be excluded due to difficulties to get in touch with the right persons.

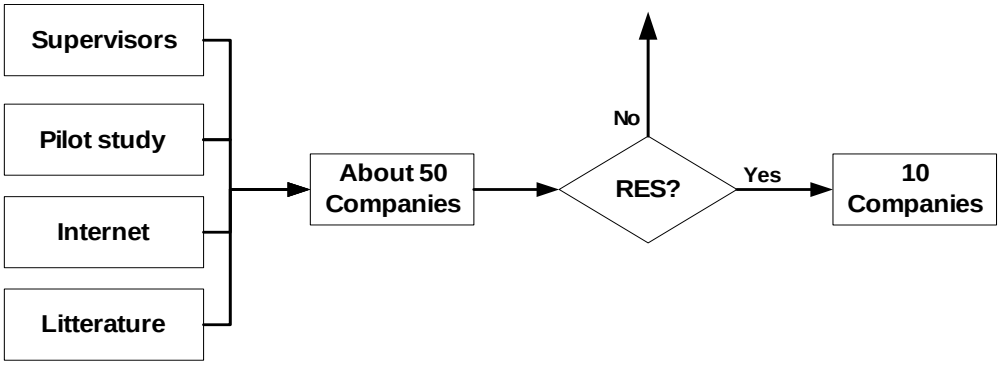

Figure 5 Selection process

4.2.5 Interviews

Ten interviews were made. The interviews were conducted at the respondents' workplace and each lasted for slightly more than an hour. During the interviews some respondents also gave presentations about the investigated systems and organizations. Obviously we asked for permission to record the interviews but one respondent didn't allow us to do that, leaving us to take detailed notes instead.

Since the study was meant to generate qualitative rather then quantitative input it was sensible to adopt a more open approach when conducting the interviews. Since many questions were open-ended, our interview guide was mailed before the interview, thus ensuring that all interviews followed the same general format and that interviewees could provide more informative data. The purpose of our interview guide was to enable us to carefully direct the discussion towards a few main tracks and at the same time be receptive for other input. Placing our interviews into a category they would probably be dubbed as semi-structured.

We began each interview with a brief introduction of ourselves, our background, the purpose of the interview and encouraged the respondent to discuss freely. After this the interviewee usually presented himself and the company and we began the interview with a few simple questions to make the interviewee more comfortable with the situation.

4.2.6 Analysis

When analyzing our results we adopted an approach similar to Orlikowski and Gash (1994). This inductive, qualitative approach facilitated an analysis of different actors' interpretations of RES and their actions around it. This analysis model bears some resemblance to the process of context analysis as presented by Easterby-Smith (2002), although with an aim to allow for a richness of the material to remain. It's important to point out that the goal of this survey has not been to provide a quantitative account of the prevalence of some themes, but rather a wish to provide a rich description of some of the perceived strategic roles of a specific type of system. For a graphical model of our approach see Figure 6 (below).

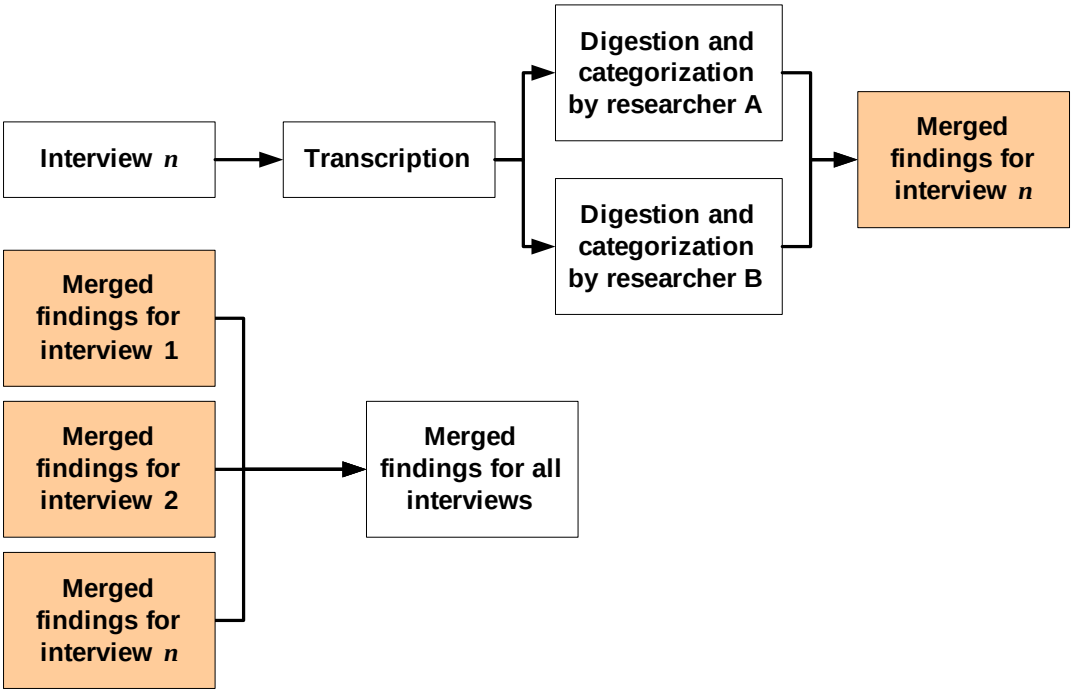

Figure 6 Model of our analysis process

To make the analysis easier to grasp each transcript was examined and digested into categories suggested by the data in order to extract the key findings. As Orlikowski and Gash (1994) we adopted a form of content analysis were the data is read and sorted into categories suggested by the data rather than imposed from outside. The two of us first examined and analyzed each interview separately in order to not influence each other. After these separate analyses we presented the material to each other to find patterns and merge our findings. The purpose of this was to identify statements that reflected assumptions, knowledge or expectations of the RES.

Once all the data for each interview was examined we began a new kind of analysis comparing all interviews in order to find patterns and common themes. In our case one domain emerged, the domain of "Technology Strategy". In this domain three frames crystallized; control, rationalization and structural transformation.

4.3 Validity and Reliability

According to Easterby-Smith et al (2002) there has been some "*reluctance to apply ideas of validity and reliability to interpretative and social constructionist research, because they might imply acceptance of one absolute (positivist) reality*" (p. 54). But he means that since these methods are becoming more conventional there is a growing need to develop the power to convince examiners, professionals and the wider public that their results should be taken seriously, which calls for an increasing focus on validity and reliability. With this in mind we will present the key concepts behind these important notions and try to apply them on our study.

4.3.1 Validity

In more traditional, positivistic research validity concerns the issue of whether what is measured really is what's intended to be measured. Or, according to Easterby-Smith et al (2002), do the measures correspond closely to reality? In the more qualitative or

social constructionist research settings the corresponding issue concerns whether the study has clearly gained access to the experiences of the informants.

Our study comprised of a number of semi-structured interviews, and was carried through with an understanding of the importance not to bias the respondent and with a goal to extract anything relevant of the informant. In order to facilitate this, both of us were always present during the interviews. When something was unclear we always followed up with new questions to gain a better understanding. In good time before each interview the interviewee received the interview-guide. We made sure he understood it, that he was the right person to talk to and that he understood our objectives with the interview.

In spite of our relative inexperience of these situations we believe that, given the circumstances, we have gained a reasonable access to the experiences of our informants. However, to really gain full access to the respondents' experiences and knowledge within the specified domain a number of different methods of data acquisition would have been useful. It would, for instance, probably have been fruitful to been able to study the systems hands-on, or at least se a demonstration of them. It would also been interesting to be able to interview more then one respondent in each organization. At the same time, you can't really squeeze everything into a limited timeframe. Given these restrictions, we do believe our approach is relevant.

Our unit of analysis were supposed to be managers with a role in the decision process related to the group of people deciding whether the investigated remote embedded system would be implemented or not. This category, however, is fairly large and the different roles among these are quite wide-ranging, hence, validity could suffer from this. If there was easier to find companies with the type of systems we were looking for the validity would have increased since the examined systems would have been more homogenous.

4.3.2 Reliability

The positivist tradition stipulates that reliability concerns whether different researchers will make similar observations on different occasions (e.g. Easterby-Smith et al 2002). This may also be true in qualitative studies but according to Easterby-Smith at al (2002) the social constructionists view on reliability concerns whether there is *"transparency in how sense was made from the raw data"* (p. 53). What they exactly mean by that is not entirely clear to us, but it seams like a meticulous account of the used method would facilitate this notion. If this is true we certainly hope to have accomplished this.

There are, of course, some issues that could affect the reliability of the study. To start with, we recorded our data using a PDA (personal digital assistant). The effect this device had on the respondent is probably very similar to that of a tape recorder, thus inflicting uneasiness on the interviewee that may have affected his answers in one way or another. By recording the interviews the informant may also be afraid of saying what they really think, to be sure, there was one respondent that actually prohibited recording because of this. Furthermore at some occasions the sound quality of some interviews was inferior leaving us to work out and interpret a sentence or two.

4.4 Further Critical Observations

In this chapter we want to point at some things that may have had a deteriorating effect on out work. First we want to mention that it was difficult for some respondents to grasp

the objective with the interview (because of our own undeveloped communication skills). This sometimes meant that valuable time was lost in lengthy explanations about our goals. Our experience in conducting semi-structured or unstructured interviews in a academic manner are, to say the least, minimal. Especially during the first few interviews we felt a bit unsecured and a bit awkward, this may have affected the outcome of the interviews in one way or another.

Another issue we have worried about is that maybe we have been too superficial when penetrating the different systems. The traditional case study approach often includes multiple interviews around the same problem. Even if our study may not be dubbed as a case study it may have been helpful to decrease the number of visited organizations and instead interviewed two or more respondents in each organization. But that would have been inconsistent with the original principal wish for us to visit as many organizations as possible.

5 Empirical Findings

In this chapter we will account for the empirical data gathered during our interviews. As discussed next, we will use Technological Frames (Orlikowski and Gash, 1994) as our main track when structuring our data. For our purposes, and as we have mentioned earlier, the notion of sensemaking concerns how people resolve uncertainty and ambiguity in organizational structures (Weick, 1995). The concept of technological frames (Orlikowski and Gash, 1994) may be a more specialized way of approaching the sensemaking domain when studying different IT efforts.

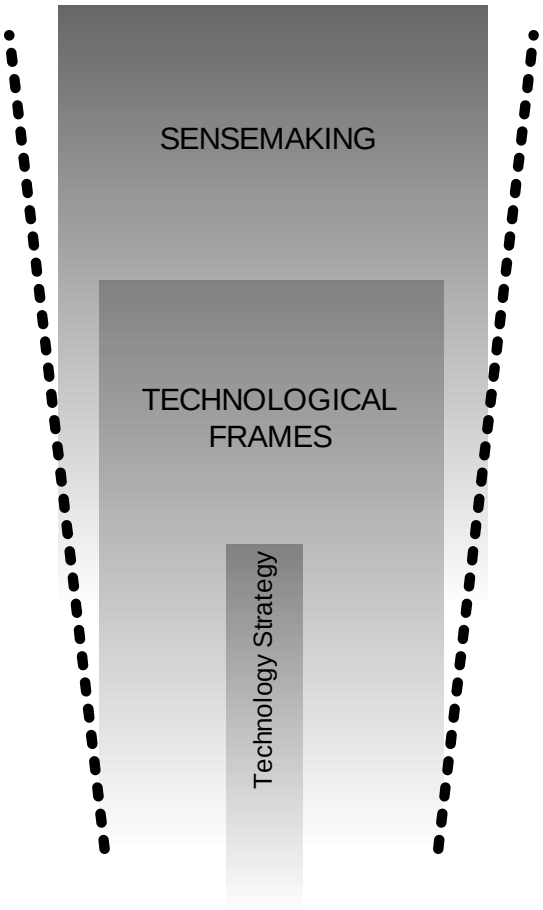

Figure 7, The relation between Sensemaking, Technological frames and Technology strategy

As mentioned earlier technological frames are about how organizational members, in our case managers, believe a particular IT-artifact is affecting them and may be used to explain and anticipate actions and meanings (Orlikowski and Gash, 1994). Our data primarily implicated the use of one domain, i.e. “Technology Strategy”.

5.1 Technology Strategy

During our study we explored the organizational impacts as a result of an implementation of a Remote Embedded System (RES). We wanted to explore the internal drivers behind these implementations in order to find out how managers perceived the strategic role of their RES. From the empirical mass one domain crystallized and is called “Technology Strategy”. This domain contains people’s views of why their organization implements a new technology. It also considers peoples

understanding of the vision behind the adaptation decision and its probable value to the organization. As mentioned earlier three frames have crystallized in this domain: rationalization, control and structural transformation.

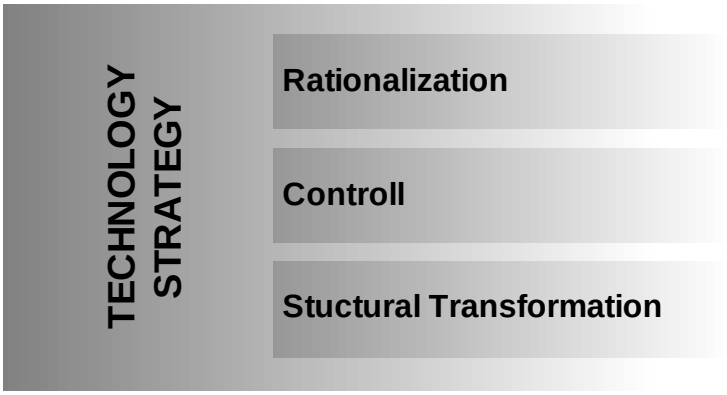

Figure 8, the frames found in the domain of Technology strategy

5.1.1 Rationalization

This frame was held by managers who claimed their remote embedded system concerned the concept of making different organizational aspects more effective. Generally speaking, making an organizational task or process more effective is primarily accomplished by producing more [of something] with the same amount of used resources or by decreasing the amount of used resources for a given (often sustained) result. It often concerns making specific processes or tasks and thus people's way of work more efficient. Ultimately, the goal of any investments is to render lower costs or increased incomes or both, even if it sometimes is a long-term goal. Most organizations considered it important to pay attention to rationalization and organizational effects when implementing a RES, while some considered this a main goal. The other frames discussed in this chapter (control & structural transformation) are more directly coupled to other reason while the notion of rationalization becomes a positive side effect. In the "rationalization-frame" the respondents have more clearly, more obviously claimed rationalization and efficiency promoting as the main drivers for implementing a RES and thus the managers' perceived strategic role of the system.

One system (C1Sys1) used at C1 was built in order to manage the logistics of bulk gases in order to improve order handling and planning, clearly related to rationalization. The system was intended to serve as a tool for C1's logistics department in order to make operations more efficient. It used remote sensors placed in large customer gas-tanks to provide the order-/logistic system with information about gas-levels and usage, thus enabling optimized delivery. The system also provided information to the production department that made it possible to more accurately estimate production needs.

The second RES the company (C1) had implemented (C1Sys2) was used to gain better control of their inventory. Although the main strategic role of the system was perceived as being control, one important spin-off can be related to the frame of rationalization. The previous, manual system didn't work in a satisfactory way and the wastage wasn't acceptable (Quote 1). The goal wasn't really to reduce the company's use of resources, but rather to produce more with the same use of resources.

> *”It should be as many gas-containers as possible at the customers, it’s only there they generate income. As soon as they arrive to a customer the rent starts ticking. Otherwise they only add to the cost of capital…”*
>
> *”Det ska vara så många [gasflaskor] som möjligt ute hos kund, det här genererar ju intäkt. Så fort den kommer ut till kund så tickar det en hyresintäkt. Annars kostar de bara kapital...”*
>
> *(Quote 1, Product manager, Company C1)*

It might be interesting to note that there were other purposes with the system, such as safety concerns and customer satisfaction, but this is more related to external strategic and visionary arguments rather then to the frame of rationalization discussed here.

Company C7 is a fairly large actor in the Nordic petrochemical industry. During our interview with this company we discussed their carpool franchise and the implications of the RES used to manage this. When discussing the implications of the system it became clear that they used the data from the RES in order to optimize the number of cars in their different carpools, thus weighing the probable result against the amount of used resources.

> *”…if it is too low [the utilization ration] then there are too many cars and too few customers, is it too high we have too few cars. When it’s above 60% we have to increase the number of cars…”*
>
> *”...är den för låg [utnyttjandegraden] så är det för mycket bilar och för lite användare, är den för hög då har vi för lite bilar. Så att när den är uppe på 60%, då måste vi skjuta på mera bilar...”*
>
> *(Quote 2, Concept developer, Company C7)*

This can be said to relate to the frame of rationalization since the balance between having too much unused resources and not being able to satisfy customer needs can be optimized.

The interviewee from company C6 points at the importance to consider the number of users when evaluating the rationalization efforts. The respondent meant that the focus on seemingly insignificant and small processes could increase efficiency in a larger context. They built a system (C6Sys) that mainly kept track of customer-company interactions that minimized the printing need. The system saved two or three minutes of time for each time a client used to make a printout. Because of the great number of users this alone covered the cost of the system (Quote 2). From this quote it is quite safe to conclude that the strategic role of this system was to improve efficiency. The respondent meant that the challenge is to find that key function which can be applied to a large number of users.

> *”Our calculations showed that only by eliminating the process of printing a document, waiting, putting it in a envelope could save a lot of money… It’s about having more effective information management…”*
>
> *”Och vi mätte ju fram till att bara slippa stå vid printern och skriva ut rapporten och lägga den i ett kuvert skulle ju spara ganska mycket pengar… Att ha en effektivare informationshantering…”*
>
> *(Quote 3, Manager, Company C6)*

5.1.2 Control

The managers who held this frame perceived the strategic role of "their" RES as being improved control. The technological frame of reference referring to control is about order and structure, mainly in the operations of a business. Even though having operational implications the interviewed managers considered this a strategic benefit (or a strategic role) of the system. It may be about the possibility to trace inventory or about a company's ability to make better plans. One reason, among the interviewed companies, to implement RES was to gain better control and order in their organization. Many companies said this was a positive side effect and two respondents (C3 and C1) claimed control and order as the main strategic role of their RES (C3sys and C1sys2).

Unfortunately we were not allowed to record the interview at company C3 and cannot, because of that, quote the respondent word for word. The company is a major actor within the security service sector and provides a variety of services and products. To sum up, the discussion revolved around a recently implemented system that kept track of safety-containers used for transportation of valuable gods. The system incorporated handheld computers and utilized EAN codes to pinpoint and track the location of the containers. The main purpose was to keep better track of their operations. According to the respondent the improved control gave beneficial spin-offs such as a simplified daily planning process, timesavings because of the simplified administration and easier profitability calculations.

The respondent from company C1 said that the main reason to implement one of their RES (C1sys2) was to get better control of the gasholders used as an important part of their rental services (Quote 4). C1 is a large multinational company that manufactures and distributes industrial bulk-gases. On each of the company's gas-containers there is a computer chip with a unique identifier that is read at each pick-up and delivery. The data is stored in a central database and published on the web (if the customer paid for that service).

> *"... all these gasholders at the customers that they are obliged to pay rent for didn't always match [our inventory]. If they had 100 gasholders according to our record there might be 50 or 200. It was more common that there were more gasholders at the customer than in our records. We heard from the customers that paid too much but the others were content. It was something like a black hole of gasholders on the market. … It was interesting for us to get some control both in terms of revenue and security."*

> *"Ja alla de här flaskorna som fanns ute hos kund som dom ska betala hyra för stämde ju inte riktigt alltid, hade de 100 st flaskor enligt vårt register så kanske det fanns 50, eller att det fanns 200 flaskor, det var mer vanligt att det fanns mer flaskor än vad de kunder som ansåg att de hade…Ääh vad ska jag säga, de hörde av sig de kunder som fick betala för mycket och de andra var nöjda. Så att det fanns något som vi kallade för svart hål av flaskor ute på marknaden. Vi visste ju också hur mycket vi hade investerat i under årets lopp… Men det var intressant att få lite kontroll på det här, både intäktsmässigt och säkerhetsmässigt"*

(Quote 4, Product manager, Company C1)

Moreover the system (C1Sys2) made it possible to get essential data for statistical and economical calculations and the system (C1sys2) was also used as a way to evaluate (or control) the dispatchers' performance.

Another example of technological frames related to control comes from a municipal service provider of public transports, P2. One of their systems (P2Sys) was used to gain more control of some aspects of the operations, and thus perceived as having a strategic role of improved control, mainly related to the temporal and spatial whereabouts of the vehicles. This improved control was used to develop customer services as well as building a database to be used as a tool for route planning.

> *"The thought is that we should have control over every single vehicle, wherever they are"*
>
> *"Tanken är att vi ska ha koll på varje enskilt fordon var den än befinner sig i hela linjenätet."*
>
> *(Quote 5, Manager, Company P2)*

The data was stored in a large database and was later used as a means to simplify the planning process.

5.1.3 Structural transformation

This frame was held by respondents that perceived the strategic role of a RES as being related to structural transformation. It concerns the organizational effects and drivers behind structural transformations. Some of our data, later accounted for, relate to improvements of the users work environment while some data relate to other aspects of structural transformation. In this frame we will also account for some of the problems the respondents mentioned, since they often were related to structural or organizational issues.

The respondent at company C2, for instance, claimed that their remote controlled heating and ventilation system for commercial buildings gave positive effects on their work environment (Quote 6), thus he perceived the strategic role of the remote embedded system as being related to structural transformation.

> *"People don't have to sit here. If there is an alert at night it [the system] can page the person on duty who can be in bed at home. /…/ They don't have to go to the office to check up, but can use their laptop to connect [to the system]."*
>
> *"Det behöver inte sitta folk här. Kommer det in ett larm nattetid kan den [systemet] skicka ett minicall till jourpersonen som kan ligga hemma /.../ de behöver inte åka in för att kolla här utan kan koppla upp sig med sin bärbara."*
>
> *(Quote 6, Manager, Company C2)*

The respondent at another company (C6) emphasized the benefits of developing their own organization, claiming that therein lays important benefits, consequently perceiving the strategic role of the RES as being structural transformation. In more general terms the respondent emphasized that the objective of system development should be to eliminate stages in the operation rather than adding new ones. The respondent continues that if they find the lowest common denominator, find the function "everybody" needs,

it would represent a great benefit (Quote 7). On the same note, the respondent later claimed that creating the highest possible value (in monetary terms) is rather about making a lot of users' tasks a little easier than a few users tasks completely re-engineered (Quote 7).

> *"The large internal benefit is related to developing your own organization, and in that case you can't really provide anything new… And that's when it really becomes interesting because then everyone needs this, but in different ways… It's about raising the floor for everybody in the organization rather then to lift the ceiling for a few… What brings the big money is to raise the floor for everyone"*
>
> *"Den stora nyttan ligger ju trots allt i att utveckla den egna organisationen, och då kan man inte tillföra någoting nytt... Det är mycket där den interna nytta ligger... Det handlar om att lyfta golvet för alla i organisationen snarare än att lyfta taket för några få… Det som ger dom stora pengarna det är ju om man kan lyfta golvet för alla…"*
>
> *(Quote 7, Manager, Company C6)*

Furthermore, and on an even more general level, they meant that the more concrete, more specialized, applications only will be of use to a more limited organizational unit. And claims that if you want to accomplish a more thorough change throughout the organization, you have to pay closer attention to the human factors (soft issues) (Quote 8).

> *"... I believe that you after all can benefit from the measurement technology... We have an enormous data overflow… you have learned to use multiple sensors in another way… But it's often [used in] specialized applications… But if you need to make radical changes in the organizations way of working, it's the soft issues that's important…"*
>
> *"… Jag tror att man i grund och botten har en nytta av mättekniken... Vi har ju dataöverflödet som är enormt.. man lär sig hantera många sensorer på ett annat sätt, det har vi behov av på många olika sätt... Men det är ofta specialapplikationer... att den här personen behöver lösa det här... Men om man ska göra stora förändringar på organisationens sätt att jobba, då är det mera de här mjuka sidorna som är viktiga..."*
>
> *(Quote 8, Manager, Company C6)*

On the other hand the same respondent (at company C6) later pointed at some organizational problems as they claimed that the problem wasn't the actual objective or goal with the system, i.e. to develop a RES, but rather the organizations repugnance to adapt their way of working. The respondent even meant that the consequence of introducing a new system could be that the using personnel no longer have the abilities or characteristics required by the new task (Quote 9).

> *"...the problem wasn't really to make a measurement system, but the problem was to get the organization to accept that this was a new way of working with their customers... and that's not accomplished in a day…Maybe this calls for a new type of personal characteristics [among the staff]… not the type that enjoys visiting customers and give recommendations… you can't tell them that 80% of their work will*

involve remote operations from the office… This calls for a completely new type of personal characteristics…"

"… problemet var ju inte att vi skulle få till ett mätsystem, utan problemet var ju att få organisationen att acceptera att det här var ett nytt sätt att jobba med sina kunder... det gör man ju inte över da'n... Det är kanske en helt annan typ av människor som ska jobba... inte dom här som tycker att det är kul att åka ut till kund och komma med rekommendationer, då kan man ju inte säga att dom ska jobba 80% hemma och sitta och göra det här fjärrmässigt... Det är ju en annan typ av människor man ska ha då..."

(Quote 9, Manager, Company C6)

During the interview with company C8, a unit responsible for developing RES for their industrial parent company, they mentioned that a lot of problems are more related to organization and information management rather than to technology and infrastructure issues. They say that the great challenge lies in changing the way of work, changing the structures and the processes (Quote 10).

"We have identified that the great problem to get these services to work is not the technology in the car nor the infrastructure. No, the greatest problem, or change needed, is to find a way to understand how to benefit from this in our companies. How do we connect this new information flow to the departments that actually needs to do something with the information. /…/ That's where I believe the great challenge lies. This means that, for instance, in product development we have to change our way of work, change structures and processes… "

"Vi har identifierat så långt att det stora problemet med dessa tjänster för att få dem att funka, det är inte tekniken i bilen, det är inte fråga om att det saknas någon infrastruktur utan den stora förändringen som gör att vi inte kan hitta värden är att vi fattar inte hur vi ska dra nytta av detta i våra företag. Hur kopplar vi det här nya informationsflödet in till de avdelningar på Volvo som faktiskt behöver göra något med informationen. /.../ Det är där jag menar att den stora utmaningen är, för t.ex. produktutveckling innebär det här att vi måste förändra vårt arbetssätt och strukturer och processer."

(Quote 10, Manager, Company C8)

5.2 Main points

To recapitulate, the frame of control seems to be quite closely related to the frame of rationalization. Rationalization and control seems to be the most common perceptions about the strategic role of a RES. Control concerns structure and order in the operation processes of a business while rationalization concerns the wish to make different aspects of a business more efficient. The frame of "structural transformation" deals with perceptions both related to work environment issues as well as more general reorganization efforts.

6 Discussion

In accordance with the qualitative research perspective this section is devoted to deeper penetrate and further interpret some of the empirical data presented in the previous section. We will account for our view on some of the findings and apply a more holistic perspective when searching reasons for and meanings of the strategic role of RES. Furthermore some conclusions will be drawn from the empirical findings presented earlier in conjunction with the essences of the discussion-chapter.

This section takes its starting point in the interpretation of the findings. To facilitate readability we will use the same structure found in the "findings-chapter" (i.e. control, rationalization and structural transformation). We will also incorporate some of Weicks (1995) properties of sensemaking as a way to further make sense of the acquired data. We will discuss the distinctions between Embedded Systems and RES (if any), explore the possibilities of some other drivers and, finally, present a brief discussion about the implications of the congruence of frames.

As mentioned earlier, Orlikowski and Gash (1994) means that technological frames are about organizational members' assumptions, expectations, and knowledge of a particular IT-artifact. We have used this theoretical concept to analyze and order our data to facilitate the interpretation of the respondents' perception of the motives behind an implementation and thus the perceived strategic role of a remote embedded system. The notion of Orlikowski and Gash's (1994) technological frames emanates, to a large extent, from sensemaking theories, where Karl Weick is an important contributor (e.g. Weick 1995), as described earlier. One may view technological frames as a more concrete application of sensemaking in a context including IT-artefacts. Even if it is somewhat of a logical summersault we do believe it is meaningful to use some of Weicks properties of sensemaking (1995) in order to shed some more light upon various aspects of the technological frames.

As mentioned in our findings, the data primarily implicated the use of one domain, i.e. "Technology Strategy", and within this domain, control, rationalization and structural transformation have been the most common frames. In our case, this domain mainly reflects the managers' view of why their organization is implementing an IT-system.

But how do these frames relate to each other? During a qualitative study, which by nature is heavily dependent on verbal data, it's always a risk that different people ascribe different meaning to the same word (semantics). But still, we do believe that these frames can relate to each other by describing their "distance" from what could be described as the general or universal objective of any commercial business, i.e. to make money (see Figure 9).

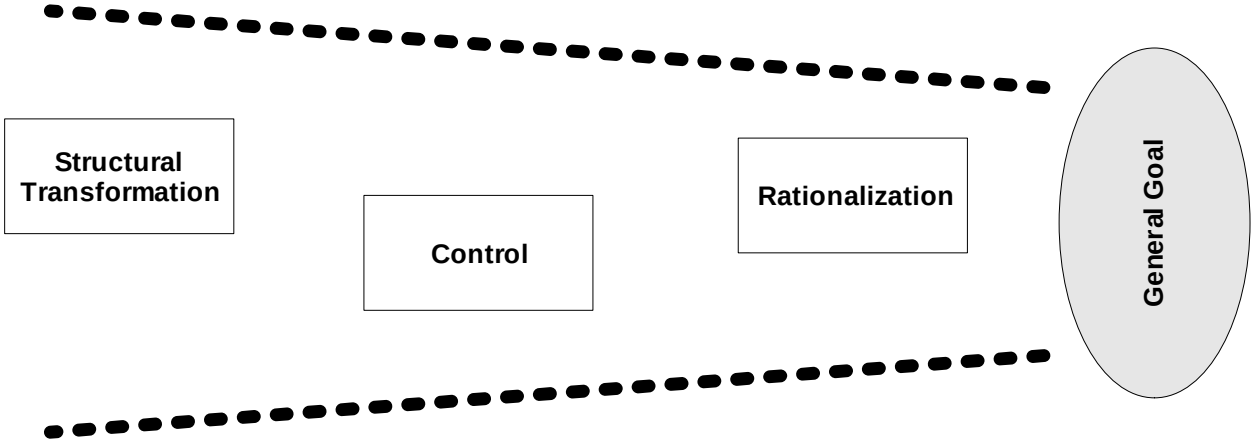

Figure 9, Graph over the relations of the frames and their "distance" from the general goal of any commercial business (i.e. to make money)

Obviously these frames are somewhat intertwined and overlap each other, but in order to facilitate interpretation and discussion they are treated as separate analytical entities.

But is it always true that the general goal of business is to make more money? Besides a number of commercial businesses we have also interviewed two public administration organizations. In fact, one of the companies may be considered as a commercial municipal company while the other is more similar to a "common" public organization. But to nuance the notion of "the general goal of any business", mentioned earlier (see Figure 9), it might be interesting to note that this objective probably doesn't apply to public administrations. The pragmatic difference probably lies in how they regard the objectives of their IT-systems. While commercial businesses may pursue profits, traditional public administrations may be more prone to make the most of the funds assigned to them. Furthermore, it may be the case that many employees, both managers and staffs, not necessarily sees the "general goal" since this may not be communicated adequately by top-level management. Or, even if there is a general goal of commercial businesses, even if it is adequately communicated, it still isn't certain that every employee of a firm actually ratifies that goal.

Next we will expand our discussion by discussing and further interpret the findings. We use the same structure as in our findings in order to facilitate readability.

6.1 Rationalization

One may wonder if not all investments in IT-systems are supposed to render rationalization effects. In a fully rational world this may be true, and to a significant degree this is probably true in our actual, not so rational world as well. As mentioned earlier, the other frames found in our survey are, according to us, further from the general goal of business, while the frame of rationalization is more directly related to this ultimate goal of any business, i.e. to make money (see Figure 9).

Although not closely related to the meaning and motive of an IT-system, but rather to the way a meaningful application is worked out, one respondent mentioned that a great number of potential users together with a relatively small change in their work process would yield a more beneficial return then vice versa. This is probably true in more ways than one. Apart from the apparent rationalization advantages, this strategy probably doesn't demand as grueling education efforts as IT-systems with a more thorough

reengineering of a work process, and the education is probably easy to conduct with IT-based, asynchronous interaction (e.g. web-based training). Clearly this has to apply to a more general function or process (such as printing or mailing), since such processes represent a more common denominator than, for instance, an IT-system targeted to revolutionize order handling.

One company (C1) claimed that their personnel were proud of the fact that one of the investigated systems (C1sys1) had made them better and more efficient in their everyday work. This imposed a more professional identity and consequently relates to Weick's (1995) thought of sensemaking as grounded in identity construction.

6.2 Control

Obviously it is, if not impossible at least, very hazardous to speculate about why the frame of control were brought up among the respondents, but one reason could be the unconscious cultural considerations affecting members of a certain community, maybe Swedish managers are more interested in improved control than, for example, Spanish managers (or vice versa). The company culture may also have an effect on the domain of control. Maybe more hierarchical, traditional organizations have a stronger emphasis on control and order than flat, loosely coupled organisations.

According to Weick (1995) one property of sensemaking is that it's focused on and by extracted cues. He means that extracting cues is the process of noticing what is relevant and useful to mentally represent stimuli (or input). Since the control over cues is considered as one source to influence and power, it is interesting to ask whether these cues are imposed from top-management or if they are a part of the company culture. Maybe companies with a more rigid and traditional hierarchy are more prone to adopt a strategy related to control then companies with a flatter organizational structure. It might be likely that control and order are more important when a top-down decision has been made. In other words, are the cues for sensemaking focused on control and are these possible cues imposed from top-management or are these cues a result of the corporate culture?

In the technological frame of control the direct or indirect focus on different statistics is fairly evident among our respondents, e.g. coherence to a timetable or the number of bottles per customer etc. Maybe that is quite natural since, at least in our opinion, statistic material is a recognized way to motivate certain decisions and thus a means to exercise control. There is also an interest to facilitate different planning activities with the examined systems. On the same note, this is also a means to exercise control since planning efforts most often results in a more orderly execution. Control and order were also recognized as a means to increase the level of customer satisfaction since these efforts were thought to facilitate a more correct and timely reply to customer inquires and needs among the respondents.

One system in (P2Sys) was quite similar to a traditional decision support system (DSS) in that it was used to facilitate the decisions for an operation-planning function in the organization, i.e. the data from the RES was used to make decisions about future actions

Another interesting aspect one company (C3) mentioned was the positive impact the system had on the appearance of the company as it gave a more professional impression. Through the lens of Weick's (1995) properties of sensemaking this can be said to cohere to the thought that *sensemaking is grounded in identity construction*. This means that people learn who they are by acting and by reflecting upon those actions, but

also by the actions, or rather the reactions, among those around him or her (Weick 1995). Seen from an IT point of view this could be the case at company C3. The company claimed that a major benefit of their RES was that the improved control nurtured a more professional identity among the employees and thus affected the impression of the company among external entities.

6.3 Structural Transformation

This frame concerns the real and probable organizational effects and drivers behind structural transformations. As mentioned earlier Alshawi et al (2003) mean that an outcome is the result of introducing a new IT system while a benefit is what is later derived if the new capability is exploited (p. 419). It might be a bit contradictory to our own categorizations but, if complying with this notion the frame of structural transformation may be viewed as an outcome while, for example, an improved work environment may be viewed as the actual benefit. Some of our data relate to improvements of the users work environment (a benefit) while some data relate to some other aspects of structural transformation.

Some discussions revolved around the work environment of the employees. It seems to us that this issue is quite important to some companies. But it may be a bit naive to believe that any company would invest a vast amount of money in a system that would improve the users work environment unless they thought it would pay-off somehow. Some examples of typical pay-offs related to these efforts could be decreased staff turnover, more satisfied employees or easier recruitment, etc. To be sure, some evidence may suggest (e.g. quote 6) that work environment promoting measures also can render positive effects on the efficiency. For instance, staff may not need to go to the office in order to check different alerts but can work from home, which consequently leads to reduced costs (although we have no hard evidence of that) for the company as well as a improved work environment for the employee.

However it is interesting to ask one self if the prevalence of work environment issues today is as frequent as it was a few years ago. Maybe the examined systems were introduced during a time of prosperity when there were a shortage of personnel and thus a problem to find them. Today it might be different, the companies doesn't need extra measures in order to fill their positions. As a consequence one could argue that the occurrence of this frame correlates in inverse proportion to the state of the market.

In the same spirit it could be that this issue also is affected by the regulations and culture of a specific region. Our respondents have all been active in Sweden, thus implying a certain culture as well as the obedience to Swedish rules and regulations. It would be interesting to make a similar survey in another country, like USA, to find out if there is an equal focus on work environmental issues.

One company, a provider of RES-systems, mentioned that the recruitment efforts of one of their customers was highly facilitated due to the improvement of the professional identity the work benefited from after implementing their system. It was considered to be a more "high-tech" job among the users after the implementation (company C0). A municipal public service provider claimed that their system gave the users a more professional identity, an identity of "I-am-good-at-what-I-am-doing" (company P2). Both of these examples can be argued to relate to Weick´s (1995) claim that identity construction is a property of sensemaking.

A lot of perceptions, related to the implementation of Remote Embedded Systems (RES), originated from soft issues. With this we mean those aspects of the system development and implementation process concerning organizational or human factors. Even though this may not be a unique matter for RES it's an interesting and important issue that, depending on the way it's managed, can help or hinder a system development project. A company's organizational structure is, as we all know, a rather complex phenomenon. This became quite clear when analyzing the issues some of the respondents' companies struggled with. For instance this can be about directing information flows to the right organizational receiver or about the problems around the change of individual's way of work. The companies that discussed organizational problems the most were company C8 and company C6, but others expressed similar concerns as well.

When approaching the topic of issues and problems it's quite interesting note how they are related to organizational change and transformation in work processes, and not as much to technical problems. As mentioned in our findings, one respondent even meant that introducing an IT-system that alters the way of work to much calls for a new set of personal characteristics among some members of the workforce. The implication of this can be rather significant since the employee's personal ability and competence, once matched with a specific task in the company, no longer may be valid. However, this may probably be avoided, at least to a certain extent, by incorporating the users of any IT-system in the development process. To be sure, our respondents weren't members of the technological part of the organization, but rather members of the "business part". But if there were any significant technological problems with the investigated systems they would probably know about it.

6.4 Distinctions between Traditional IT-systems, Embedded Systems and RES

So, what is unique for the "remote" aspect of our investigated systems? If we at first looks at the differences of a remote embedded system compared to IT-systems in general, it seems to us that the big, and quite obvious, difference lays in the used technology. It is our belief that the benefits of the remote embedded systems (RES) investigated during our work are quite similar to the benefits rendered by other, technologically quite different, systems. For instance, in a survey conducted by Suwardy et al (2003), were the objectives of the study was to obtain an understanding of the motivation of benefits from IT investments, they conclude that the primary reasons for investing in an IT system were: increased operating efficiency, better information management and to reduce cost. They also mentioned that obtaining competitive advantages and to meet customer expectations were important benefits, but that doesn't apply to our work. The first three reasons are quite closely related to our findings whereas the last two are more related to external benefits, not included in our survey. This could be an indication to that there are few differenced between RES and traditional IT-systems in terms of benefits.

For instance, it wouldn't surprise us if an ERP[5] system's perceived strategic role among managers was an improved productivity and as such an obvious member of the

[5] ERP, Enterprise Resource Planning

rationality-frame, or if a CSCW[6]-system's most important perceived strategic role was to improve organizational cooperation, thus a member of the structural transformation frame.

But if we discuss the differences between traditional embedded system and remote embedded systems (RES), the story may be a bit different. As described earlier, embedded systems are quite specialized and are often, if not always, developed for a very specific task. It seems to us that the majority of embedded systems either are made for use by engineers or technicians (e.g. control devices on different machinery) or are used as a HCI[7] tool for a wide array of applications (e.g. microwave ovens, Climate control in cars and so on). But when you add remote capabilities some interesting implications arise. Even if the embedded system used as a data acquiring remote client is pretty much the same as the traditional embedded system, the local receiving device not only replicates the raw data but, at least in our cases, actually transforms it to meaningful information possible to use by a much wider clientele. When this happens it is probably more meaningful to not se a RES as a system category by itself but rather a part of a greater system (such as an ERP, a DSS[8] or a CSCW system).

6.5 Other drivers

We have tried to discuss how managers perceive the strategic role of the investigated remote embedded systems and tried to explore the reason for those perceptions. But there may be other drivers affecting the reasons for a certain investment decision. We would like to emphasize that some points and speculations made in this small section might be a little over the top and therefore should be viewed with a healthy amount of skepticism. But never the less, these guesses are not entirely out of the blue and it's probably nothing wrong in giving these aspects a thought before approving a IT (or any) investment.

On an even higher level, it may be interesting to consider whether an investment decision is driven by functionality or technology. In our own words, functionality-driven IT-investments have their origins in a wish to improve a process, to address a organizational issue or to solve a functional problem, i.e. the idea to change some functional issue comes first and the technology comes later. On the other hand, we mean that technology-driven investments take their starting point in a (often new) technology and a use of that technology is "invented" or cast about for. Although not as harsh as described here, but the later was actually the case in one of the interviewed companies (company C1). The company is, according to the respondent, a technology-friendly company that did, in some respects, implement one system (C1Sys1) because of their interest in the new technology.

It seems like almost anyone that has worked in a fairly large company feels there is an incessant stream of quite grueling reorganizations. Surely not all reorganizations are the blessings they were said to be or the organizational equivalent of the knight in shining armor. It might be a bit harsh but it's our opinion that at least some reorganizations is the result of newly appointed managers eager to prove their ability to take action. If

[6] CSCW, Computer Supported Collaborative Work

[7] HCI, Human Computer Interaction

[8] DSS, Decision Support System

making an analogy to IT-systems, it's not far fetched to believe that quite a few systems have their origin in these kinds of reasons as well, but then dressed up in more marketable arguments. Or maybe not, maybe the reason really is a genuine wish to improve the efficiency of the organization.

Obviously all employees of a firm are expected to comply with their company's rules and guidelines, but at the same time it's very hard to expose hidden agendas. If, for example, a middle manager wants to implement an IT-system that he knows will increase his power and influence, he could, without too much difficulty, disguise his true personal motive or driver with reasons more in line with company objectives. We haven't found any evidence of this kind of behaviour, and haven't even tried to, but we're quite certain it actually exists. Consequently it is interesting to regard factors like politics, prestige and personal drivers prior to making IT related investment decisions.

6.6 Congruence of frames

In the theoretical framework of technological frames developed by Orikowski and Gash (1994) the notion of "congruence of frames" is a key component (see chapter 2.3.1 above). It concerns the fit between different key-groups' frames of reference and they mean that incongruence between key groups is a common reason for unsuccessful IT-efforts. Since we only examined one group (managers), it's really quite hazardous for us to say anything about this. However, the implication of this is equally important. Since group frames are unlikely to be shared across the different stakeholders groups (Calder and Schurr, 1981), the frames of the one key group examined and presented in our thesis and the other potential key groups are probably incongruent. If, for instance, users are one key group, it's not far fetched to believe that they would be a tad more reluctant towards the managers' goal to increase the control of their work.

Harmony between the systems strategic motives and the core values of the company or at least the values of the top-level management is probably important in order to get approval for the implementation. With a little good will, this could also be related to "congruence of frames". In many ways this may also cohere to the notion of one of Weik's (1995) properties of sensemaking as he claims that *sensemaking is grounded in identity construction*. It can be argued that the managers' own perceived identity might affect the decisions around a certain IT-system. If, for example, a manager sees himself as an orderly and organized person, he's probably more prone to approve systems that emphasize control, such as those described under "control" in "findings" (above).

7 Conclusion

The purpose of this thesis has been to shed some light on how managers perceive the strategic role of remote embedded systems in organizations. We have used theoretical perspectives from Weik (1995) and from Orlikowski and Gash (1994) in order to do so. During our work three frames crystallized. We have argued that rationalization, control and strategic transformation were the three most common strategic technological frames among the respondents. In this section we have only concluded the results directly emanating from our empirical findings.

The technological frame of Rationalization

The interviewed managers belonging to this frame meant that the strategic role of their remote embedded system (RES) was to make a process or a function in their organization more efficient.

The technological frame of control

The respondents included in this frame meant that the strategic role of their RES was to bring order and control to their business.

The technological frame of structural transformation

The interviewees belonging to this frame said that the strategic role of their RES was to impose some type of structural transformation or organizational change. Some respondents said that the strategic role of their RES was related to work environment improvements while others were more general and meant that their RES imposed a positive change in the way they worked.

The problems of implementing a RES were mainly related to the human factors due to a change in their work environment while the more technical problems weren't as significant.

8 Acknowledgement

This work began in February 2003 and our plan was to submit it for examination in May that same year. Because of a number of factors, both internal and external, the work was delayed. In order to satisfy our external principal we first focused on the report for them, and later on the academic work. During the prolonged extent of our work we received excellent help both from our two supervisors at our external principal as well as from our academic supervisor Ph. D. Rikard Lindgren, they were all encouraging, supportive and a joy to work with.

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10 Appendices

Appendix 1 – List of interviewed organizations

Appendix 2 – Interview guide

Appendix 1 - List of interviewed organizations

Company Alias	System Alias	Use Characteristics	Technological Characteristics
C1	C1Sys1	DSS, order/transport of bulk-gases	Remote monitoring
	C1Sys2	Control/supervision of gas bottles	Remote monitoring
C2	C2Sys	Control/supervision of heat and ventilation systems	Remote monitoring and control
C3	C3Sys	Control/supervision of safety containers	Remote monitoring
C4	C4Sys	Control/supervision of car park systems	Remote monitoring and control
C5	C5Sts	Supervision of bearings	Remote monitoring
C6	C6Sys	Control/supervision of bearings in wind power stations	Remote monitoring
C7	C7Sys	Control/supervision of vehicles in a carpool and remote control from cars to main system	Remote monitoring and control (duplex)
C8	C8Sys	Not yet implemented	Remote monitoring and control
P1	P1Sys1	Supervision of speed limits	(GPS, active throttle) Self contained remote monitoring and control
	P1Sys2	Control/supervision of traffic	Multiplex remote monitoring
P2	P2Sys	Control/supervision of public transports	Multiplex remote monitoring

Appendix 2 - Interview guide

- **Introduction**
  - Brief presentation of ourselves.
  - Background. What we do and the purpose of this interview (main focus on the internal benefits)
    - Main purpose:
      - Benchmarking
      - Focus on the internal benefits
      - What did the company do? Success or failure?
  - Information about the company and the interviewee's part in the company.
    - Comprehensive questions about the company:
      - Core business?
      - Employees?
      - Multinational?
      - Affiliated company?
      - Customers?
- **Telematic services (What, How, Why, Internal/External)**
  - Interviewee tells about their telematic services (What)
    - Technical (overall)
    - Functional
  - How did you reach this telematic resolution?
    - How was it before? (Evolution/revolution)
  - What kind of internal benefits does the telematic service provide? (Why)
    - Why?
    - Strategic/tactical/operative
    - Savings?

- How was the project initiated? (How)
  - Technology push/demand pull?
  - How did you motivate this cost?
  - Who is the internal customer?
    - Who pays?
    - Who profits on the new telematic service?
- Internal marketing?
  - How do you influence the internal customer?
    - Anchoring, push/pull, etc?
  - How do you find the internal customers?
- Can you say something about how this influenced the organization?
- What is your experience from the project?
  - Did some go wrong? Why…
  - Problems/issues
  - Unexpected events? (positive/negative)
  - Who developed the service? (In-house, external)

- **Finishing**
  - Vision of the future?