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**Article:**

Chen, H., Nunes, J.M.B., Zhou, L. et al. (1 more author) (2011) Expanding the concept of requirements traceability The role of electronic records management in gathering evidence of crucial communications and negotiations. *Aslib Proceedings: New Information Perspectives*, 63 (2-3). 168 - 187.

<https://doi.org/10.1108/00012531111135646>

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#### **Published paper**

Chen, H., Nunes, J.M.B., Zhou, L. and Peng, G.C. (2011) *Expanding the concept of requirements traceability The role of electronic records management in gathering evidence of crucial communications and negotiations*. Aslib Proceedings: New Information Perspectives, 63 (2-3). 168 - 187.  
<http://dx.doi.org/10.1108/00012531111135646>

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# **EXPANDING THE CONCEPT OF REQUIREMENTS TRACEABILITY: THE ROLE OF ELECTRONIC RECORDS MANAGEMENT IN GATHERING EVIDENCE OF CRUCIAL COMMUNICATIONS AND NEGOTIATIONS**

## **ABSTRACT**

**Purpose** - Despite its tremendous success and achievements, the IS industry has been plagued by shadows of failure and inefficiency since its early days. This paper takes the stance that poor communication with target organizations and users is one of the major causes for these problems. If this communication is not properly recorded and managed, many of the agreed decisions may never be assumed by target organizations, therefore leaving project managers entirely responsible for failures or deviation to initial requirements. Nonetheless, the vast majority of SW development companies have very weak provision for Electronic Records Management (ERM). This is evident by the persistent use of ISO 9001 and ISO90003 in their Quality Assurance (QA) and the consistent neglecting of the ISO 15489 standard for records management.

**Design/methodology/approach** - Since there are no studies in this area, this research employed an inductive qualitative research approach that consisted of a combination of critical literature review, an exploratory case-study and thematic analysis.

**Findings** - This paper reports on the study of a SW company that implemented ERM policies and an in-house system that not only supports the recording of documentation and evidence for every phase of the development, but also the very difficult processes of organizational learning.

**Practical implications** - This paper is of interest to both IS academics and practitioners, namely those interested in QA and ERM.

**Originality/value** - There is very little research in this area that can inform both academics and practitioners on how to use ERM within SW project management practices. This paper aims at providing early insights into ways of addressing this gap and at generating discussion in this area.

**Keywords** - Electronic Record Management, Information Systems Development, Project Management, Quality Assurance, Requirement Traceability

**Paper type** - Research paper

# 1. Introduction and Background

Based on the International Data Corporation (IDC) 2007 report, the global software industry overtook the hardware industry for the first time in 2006, by incorporating 52% of the entire information technology (IT) industry. According to the same source, in 2007 the global software market was valued at 229,946 billion US dollars and consequently the software industry has become one of the most important business sectors in the world market today.

Nevertheless and despite the apparent success story, the SW industry has been characterised by failure rates that would be unacceptable in almost any other sector. In fact, and according to statistics emerging from the well accepted Standish Group Chaos Report, presented and discussed by Johnson (2001) there has been little progress in success rates in the SW Industry. A close inspection of the findings in Table 1, shows that despite optimistic analysis the percentage of challenged projects has actually increased systematically from 33% in 1996 to 49% in 2000.

	<b>1996</b>	<b>1998</b>	<b>2000</b>
<b>Succeeded</b>	27%	26%	28%
<b>Failed</b>	40%	28%	23%
<b>Challenged</b>	33%	46%	49%

Table 1: This table depicts the results of the 30,000 SW application projects in large, medium, and small cross-industry U.S. companies tested by The Standish Group since 1994. Adopted from Johnson (2001).

However, patience of users and commissioning organisations is now growing thin and the conflicts with the SW industry are increasingly ending up in court rooms and multimillion litigation cases. In fact, as stated by Desai et al. (2002), “when failure occurs, one of the first remedies is often instigating litigation against the vendor or service provider”. The major contributor to this increasing litigation around SW projects lies in the failure to establish exact,

clear and definite requirement specifications for the SW being produced (Zhou et al., 2008). In truth, failure to establish definitive requirements or meet initial requirements that became obsolete during the design and development phase is often construed as malpractice, negligence or even breach of contract (Desai et al., 2002).

This is a well known and persistent problem since the early days of the industry and one that is very difficult to resolve. In fact, it is now well accepted that SW is but a component of the whole organisational Information System (IS). This must be developed considering the organisation as an open human activity system. As such, organisations are constantly evolving and are therefore unpredictable. There is no such thing as a repeatable experiment or a set in stone requirement. Moreover, human activity systems are composed of people who often have conflicting objectives, perceptions and attitudes towards the IS and its mission and usefulness. Finally, as open systems, organisations are under constant pressure from their external business environment and therefore constantly adapting to emerging market trends, innovations and customer demands. Therefore, the relationship between the organisation and its environment is not only of paramount importance, but also fluid and constantly evolving.

Therefore, establishing a precise and definitive requirement specification at the moment of establishing the contract between commissioning organisation and SW developer may not only be very difficult, but also undesirable. If the project lasts several months or even years, it is to be expected that the organisation will evolve and consequently rendering some or the initial set of requirements obsolete. Furthermore, communication with customers may change initial agreed requirements, through prototyping, testing or just shifting requirements emerging from the constantly evolving organisational environment.

As discussed by Zhou et al. (2007), this poses a number of important risks in terms of contractual relationships, project scoping and project planning. The traditional response, of both academia and the industry, to this problem has been centred on communication and user participation (Land, 1982; Ovaska et al., 2005). This implies the crucial concepts of user ownership in the design and development processes and user involvement in iterative agile

processes of co-development of the SW. Many SW companies, mainly SMEs, have espoused these principles and are now applying them in practice.

However, this communication process with the user represents a severe risk in itself for three main reasons:

- Users involved in the iterative design and development may not be the ones with decision making powers and deviations to initial sets of requirements may not be appropriately validated and approved by the commissioning organisation;
- Successive deviations (very often due to constant changes of mind by the participating users) to initially agreed requirements may not have been efficiently recorded by the developers; and the complexity of the process that leads to the final application may not have been fully understood and accepted by the commissioning organisation;
- Communication between developers and users is not a straightforward process and there are often misunderstandings, misinterpretations and misperceptions from both sides, which may lead to conflict and even breakdown of design and development teams.

Therefore, without an appropriate management of the evidence that corroborates the communication processes, the onus of responsibility will always be on the developer side. That is, in case of litigation and without an appropriate record system that provides clear evidence of user input in changes or shifts of requirements, the responsibility for development delays, budget overruns and lacks of usefulness of the SW produced will always remain with the design and development team.

In order to address these problems, this paper aims to break with the traditional view of requirement traceability which usually refers to the “ability to describe and follow the life of a requirement, in both a forwards and backwards direction (i.e., from its origins, through its development and specification, to its subsequent deployment and use, and through periods of on-going refinement and iteration in any of these phases)” Gotel and Finkelstein (1994). Consequently, the literature around traceability focuses mostly on tracing requirements changes to code changes (e.g. Markus and Maletic, 2003; Ramesh and Jarke, 2001). The early

preoccupations of SW Engineers was to be able understand requirements from their origin, through their development and specification, to their subsequent deployment and use, and through periods of ongoing refinement and iteration (Gotel and Finkelstein, 1996). This paper proposes that the fundamental issue in the case litigation is not only to be able to understand the shift in requirements, but having a clear record of responsibilities for that shift. That is, it is crucial that you can trace shifts in requirement to the authorised person that requested them. Therefore, what is needed are not just automated development tools and environments, but organisational practices that enable the recording and preservation of the evidence behind the requests for the requirement changes.

In other words, what is needed is the record of the communication with authorised actors in this process of change. This information on the requirement shift can be recorded, managed and maintained in the form of records, which “represent explicit corporate memory for the organization” stated by the British E-Government Policy Framework for Electronic Records Management (2001). The organisational process that usually encompasses the recording of evidence in organisations is known as Electronic Records Management (ERM).

However, the vast majority of SW development companies have either no provision at all or very weak provision for ERM. This is evident by the persistent use of ISO 9001 in their quality management and their consistent ignorance or rejection of the ISO 15489 standard for records management. Symptomatically, there is very little research in this area that can inform both academics and practitioners on how to use ERM within SW project management practices. This paper aims at providing early insights into ways of addressing this gap and at generating discussion in this area by both academics and professionals.

## **2. Synthesis of the Literature Review Performed**

The findings of the systematic literature review process undertaken in this area revealed that there are virtually no studies linking ERM and SW project management processes. Moreover, it became clear that ERM is used mostly by sectors subject to intense and frequent litigation such as the health sector (e.g. NHS in England), the public sector (both at central and local

levels) and service companies. In an almost independent thread of literature, it was clear that most design and development companies worldwide use ISO 9001, but ignore ISO 15489. This literature review served to inform the context for the research and define its basic concepts, namely: ERM and SW project management.

## **2.1 Electronic Record Management**

### **2.1.1 Electronic Record**

Records could be considered as one part of explicit knowledge in the organization. The Concise Oxford English Dictionary (2006: 1202) provides a definition of record as “a piece of recorded evidence or information; an account of fact preserved in permanent form.” This definition, although rather general and non-academic, is actually very clear and useful for the purpose of the research presented in this paper. It is based on two fundamental aspects “recorded evidence” that is “preserved in permanent form”. The key aspects for a project manager who wants to protect his project and his team. The third aspect that is important for a project manager is how to manage this recorded evidence, that is how to implement records management. The International Organization for Standardization (ISO)<sup>1</sup>, provides an insight into this management process, in their ISO 15489-1 (2001, Clause 3.15) Information and Documentation-Records Management standard, by defining records as “information created, received, and maintained as evidence and information by an organization or person, in pursuance of legal obligations or in the transaction of business”. Exactly what SW companies need when facing litigation over shifting requirements.

Finally, and to fully understand records management, it is important to define the context in which the management process is implemented. The International Council on Archives (ICA) Committee on Electronic Records (2005) illustrates this process by defining a record as digitally “recorded information produced or received in the initiation, conduct or completion of

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<sup>1</sup> Please note that ISO is not a direct acronym for "International Organization for Standardization", but a term deriving from the Greek *isos*, meaning *equal*. This term was adopted at the time of the creation of this organization in 1946 to avoid having different abbreviations in different languages.



an institutional or individual activity and that comprises content, context and structure sufficient to provide evidence of the activity.”

Therefore, for the purpose of this research and in the context of SW development, an electronic record is all information digitally created, received, and maintained as evidence in the initiation, conduction or completion of any analysis, design, development and installation activity, resulting from the communication with any user, stakeholder or decision maker in the commissioning organization.

Therefore, this paper aims at addressing all aspects of external communication with the development team. This does not mean that the researchers do not realize the usefulness and complexity of internal communication in SW development teams. It merely reflects the focus of the research aiming at preparing and protecting development teams in case of litigation with their customers.

It is important to note that records are expected to exhibit four main features: authenticity, reliability, integrity and usability. Based on the Clause 7.2 of ISO 15489-1, an authentic record is one has been created or sent by the person purported at the time purported. The reliability means the records’ “contents can be trusted as a full and accurate representation of the transactions or activities”. Integrity refers to the records being complete and unaltered. Finally, the usability means that the record can be accurately located, retrieved, presented and interpreted. These features are fundamental in ensuring that the quality of the evidence preserved is of the highest quality and appropriate in case of litigation (Chen et al., 2009).

### **2.1.2 Electronic Record Management**

The Records Management Standard ISO 15489-1 (2001, Clause 3.16) has suggested the definition of records management as the “field of management responsible for the efficient and systematic control of the creation, receipt, maintenance, use and disposition of records, including the processes for capturing and maintaining evidence of and information about business activities and transactions in the form of records”. This definition reflects the

record's life-cycle, usually consisting of conception or gestation phase, creation phase, active phase, and final phase or disposition (Hare and McLeod, 1997:5).

It is important to note here, that in this sense records management is very different from traditional document management or information management. The former aims at managing operational information in order to maximise operational efficiency and efficacy, whereas records management, in the sense adopted by this study, aims at recording evidence about the operational activities. Ultimately, records management may have impacts in the efficiency of the operation by adding evidence recording tasks. This is probably the main reason for the almost universal absence of records management in SW development industry.

The universally agreed standard for electronic records management is the ISO-15489-1, which aims to standardise international best practice in the field. This standard is based on the Australian Standard AS4390. The application of the ISO-15489 led to a number of specialised standards being devised by different institutions, mostly public ones, such as:

- The DOD5115.2-STD (2002): *Design Criteria Standard for Electronic Records Management Software Applications* provides implementing and procedural guidance for the management of electronic records in the Department of Defense of United States, which is reissued under the authority of DOD Directive 5015.2. This Standard sets forth mandatory baseline functional requirements, and identifies non-mandatory features deemed desirable for Records Management Application (RMA) software.
- British E-Government Policy Framework (2001): *Functional Requirements for Electronic Records Management Systems*, which describes the electronic records management in e-government in detail.
- MoReq (2001): *Model Requirements for the Management of Electronic Records*, which is supported by the European Commission and aims at guiding in the design, selection and auditing of systems for managing electronic records. It mainly focuses on the functional requirements for the management of electronic records by an Electronic Records Management System (ERMS).

Nevertheless, and despite a very careful literature review, the authors could not find any ERM standard specific for the SW industry. This realisation led to the study reported in this paper.

### **2.3 SW Development Project Management**

Turner and Simister (2000: 69) summarised project management by defining it as “the process of converting vision into reality”. This process, regardless of the methodology employed, is usually composed by a similar sequence of stages, namely: initiation, planning or development, production or execution, maintenance and controlling, and closing (Schwalbe, 2006; Allan, 2004; Turner and Simister, 2000; ISO 10006 *Quality Management-Guidelines to Quality in Project Management*).

The ISO 9000 families were developed aiming to create common standards for the quality management and quality assurance in project management regardless of the company’s size or complexity of the product or service. The ISO 90003:2004: Software Engineering -- Guidelines for the Application of ISO 9001:2000 to Computer Software, was developed for the SW Industry and provides a high-level overview and guidelines for the software development process. ISO90003 is an inclusive set of guidelines and considers a number of life-cycles emerging from the different design and development philosophies adopted by professionals in this industry. This standard incorporates five perspectives from which the application of quality in software design and development is addressed (Suryn et al., 2004):

- The *Quality Management System* that reflects the systemic perspective helps the user in verifying and/or establishing the structure and type of processes, together with necessary documentation, required and appropriate for the organization to build an effective quality system.
- The *Management Responsibility* that reflects management perspective and aims at identifying, defining and setting up the corporate policy and culture that supports the overall objective of producing quality products.

- The *Resource Management* that reflects the resource perspective and focuses on dedicated quality resources in identifying those specific issues that should be taken into consideration when building a professional team of quality specialists.
- The *Product Realization* that reflects the product perspective and aims at establishing the matrix of processes that support the creation of the software product (generic development process, purchasing), the planning and management of the realization process, the relationship with the customer and the production and post-delivery support.
- The *Measurement, Analysis and Improvement* that reflects the improvement perspective and aims at identifying the monitoring, measurement and analysis activities required to maintain and improve the quality of products.

This paper focuses on Product Realisation, that is on the product perspective. This is usually divided into: planning of product realization, customer related processes, design and development, purchasing, production and service provision, control of monitoring and measuring devices. Specifically, this study focuses on two of these areas: customer related processes and design and development.

### **3. Research Methodology**

#### **3.1 Research Aim**

The research project reported in this paper is driven by the general aim of exploring and establishing the role of ERM in supporting SW development teams and companies in tracing and providing evidence for shifting requirements. Since a desk study would only produce more theoretical propositions and discussion, the team for this project searched for a professional environment where these concepts were being used in the reality of practice, so that the phenomenon being studied could be grounded in that practice.

## **3.2 Research Design and Approach**

Since there are virtually no studies in this area, this research project employed an inductive qualitative research approach and a research design that consisted of a combination of critical literature review, an exploratory case-study and thematic analysis.

### **3.2.1 Critical Literature Review**

This study began with reviewing literature which provided a lens to identify those issues that were important to be examined and needed to be studied (Creswell, 2003). Therefore, this study reviewed literature from academic journal publications, conference proceedings and public reports on the two main areas of interests, namely: SW development and ERM.

The findings of the literature study provided three major conclusions:

1. There is a lack of research that explicitly studies the links between ERM and SW design and development.
2. Since there is no existing theory linking these two concepts, the study needed to take an inductive approach that would allow theory to emerge from the data collected.
3. Finally, it became apparent that it was necessary to use an exploratory case-study approach so that the theory could be grounded to the reality of practice.

In terms of the lens to be used in the study, the knowledge management (KM) assessment tool (KMAT) developed by Jager (1999) was adopted as the theoretical framework. The KMAT is designed to help organisations to undertake high-level assessment on organisational KM practices. ERM as a particular aspect of KM can easily be assessed using the following factors adapted and developed from the original KMAT ones:

- Leadership: emphasis on how leaders establish, develop and influence ERM processes, bearing in mind that ERM has to be compatible with the way the organisation is managed.

- Process: concentrates on the action steps of create, identify, collect, adapt, organise, apply, and share information through ERM.
- Technology: represents how the organisation facilitates communication between individual and information and communication technology (ICT) can be used to collect, store and disseminate information through records management.
- Culture: reflects that establishing a collaborative and sharing culture in the organisation is critically important.

Please note, that the research team took the decision to remove one of the assessment factors proposed by Jager (1999), namely measurement. According to Jager (1999), measurement focuses on how the organisation quantifies its explicit knowledge, the quality of the corresponding records and how ERM is implemented. However, knowledge, as an intangible asset, is always hard to measure. Therefore, quantifying the process of using records as the basic solution to enable the externalising of tacit knowledge seems a very artificial activity and one that could hardly be measured.

The four factors mentioned above were taken as the a priori categories for the thematic analysis employed in this the qualitative investigation as proposed by Nunes and Al-Mamari (2008). More specifically, these a priori categories formed a framework that was used in directing the processes of data gathering (interview) and analysis (thematic analysis) (Yin, 1994; Saunders et al., 2002). However, the employment of this framework was not meant as theoretical bias but rather as a lens for the processes of data collection and analysis. Therefore, these categories were handled as high level propositions and evolved continuously by using constant comparison against the emergent theory.

### **3.2.2 Case-Study**

Case-study analysis is a common approach in social sciences used to explore and understand complex and localised human activity systems and social environments (Zhou et al., 2008). Some of the classic studies in organisational research have been derived from such detailed investigations of (Bryman, 2002). The term “case study” has multiple meanings. It can be

used to describe a unit of analysis (for example, a case study of a particular organisation) or to describe a research method. Case study is generally accepted as a qualitative research method (Alavi and Carlson, 1992; Orlikowski and Baroudi, 1991) and according to Saunders et al. (2002), it is an approach particularly suited answers questions on human activity systems.

In order to respond to the research question and ground the investigation, this study adopted a single case-study of a SW company that is already explicitly using an ERM system. This project was conducted in Data Systems Consulting Co., Ltd. (DSC) a very successful and the largest ERP software provider in Taiwan. Since its establishment in 1982, DSC has provided SW services for more than 22,000 enterprises from a wide range of manufacturing and service industries. Besides local customers, DSC has many customers from Hong Kong, Mainland China, and Southeast Asia. Currently, DSC has 1156 employees with total assets over NT\$ 1.28 billion (DSC, 2007).

There were two main reasons behind the selection of DSC as the case study. Firstly, ERM concepts and strategies have been discussed and established in this company for more than ten years. Secondly, an ERM system has been fully integrated into the processes of different functional units, ranging from SW development teams to top management. This made DSC an ideal case-study.

### **3.2.3 Data Collection and Analysis**

Semi-structured interviews were used as the data collection technique to gather in-depth data to respond to the research question. The structure was given by the a priori categories discussed above. Interview questions themselves were open-ended and without theoretical bias. Interviews were conducted in English as almost every member of staff in the development area spoke the language.

Overall, there were twenty-one participants. The sampling was devised so that informants from all levels of the company were represented, namely: one top manager, five project managers, one knowledge manager, one records keeper, and thirteen SW programmers. All aspects of the interviews were digitally recorded and then transcribed and codified.

Gathered data were analysed by using a thematic analysis, having as starting point a priori set of themes, as proposed by King (2008). However, this research did not literally use “template analysis” in the sense proposed by King and Horrocks (2010:166-169), but a more purist thematic analysis as a way of coding and representing qualitative data. Data here meant the interview transcripts. Coding meant the identification and interpretation of themes and sub-themes in the data. Representation meant the production of conceptual maps which summarises the themes identified by the researchers and organises them in a meaningful and useful manner. Data were examined and interpreted, coded and constantly compared against themes and concepts that emerged from the theoretical framework. The process of interviewing was stopped when theoretical saturation was achieved, that is no new themes were emerging from the analysis.

## **4. Research Findings - A Theory of Use of the Existing System**

As discussed in detail above, this study used an adapted version of the KMAT assessment tool. The adaptation of the tool established for this project focuses on aspects of leadership, process, technology, culture. Therefore the findings are presented under these main themes. The general thread of the discussion follows the theme and sub-theme identification. The discussion starts with leadership in order to understand vision and general objectives of ERM in DSC, followed by a narrative of the processes involved in Product Realisation and a critique of the technological solution encountered by the company. Finally, this findings report will end with a brief discussion of cultural aspects that influence ERM in DSC.

### **4.1 Leadership**

#### **4.1.1 Management Support for ERM**

The main business aim of DSC is to remain as the top ERP provider in the South East Asian region. More specifically, as the Senior Manager stated that:



“We are committed to consistently provide SW solutions and at achieving business operation efficiency and productivity optimisation in order to help our customers’ achieve lasting success.” (Interview 2.15)

DSC has recently merged with one of top Chinese SW companies and has become one of most important player in the enterprise management software Chinese market. The company works a variety of sectors in South East Asia. This means that the company requires a continuous effort of customisation of their ERP in very different business, industrial and cultural environments. Therefore, the company has established the need to share and manage knowledge about these different environments in order to accumulate organisational knowledge and expertise that may sustain their competitiveness and success as an ERP vendor. The interview results showed that DSC Company has not only implemented quite effective knowledge management (KM) and knowledge sharing (KS) strategies, but has also obtained significant benefits from this effective sharing of knowledge. One of the top Project Managers expressed that:

“As a hi-tech company, which is knowledge-intensive, sharing knowledge could save time for staff in dealing with problems in their daily work.” (Interview 11.93)

#### **4.1.2 Management Support for Knowledge Management and Sharing**

It is became clear from other interviews and implicit in this quotation that staff is required to share past experiences, lessons, and stories, which are formalised, structured and formatted into electronic records.

“One of our jobs is to encourage our employees to share their experiences. They input all their experiences into the system themselves. We also have a record keeper that manages the system and defines access to these stories. They transform shared knowledge into records in a standardised format. They also make all records available on our Knowledge Library. We usually work with the record keeper to keep our records well updated and maintained.” (Interview 9.74)

This statement from the electronics records manager shows top management support to KM and a spirit of encouragement and motivation that characterises top management buy-in and ownership of the ERM strategies. It is clear that there is an attempt to externalise tacit

knowledge and preserve it in the format of electronic records. Moreover, the KS is practices are based of and facilitated by the implementation of ERM.

#### **4.1.3 Management Support for Paperless Operations**

Moreover, managers repeatedly referred to the implementation of “paperless operations” and the expectation of effectiveness and efficiency gains. Interviewees also refereed to improvements in business workflow, especially in highly repetitive tasks, through the use of a web-based ERM application named EasyFlow to support this paperless office work.

However, only the IT staff said that their daily business was almost “100% paperless”. Verification security, digital signatures and Certificate Authority (CA) digital certification help technical staff to identify the role and responsibilities, communicate and share information. However, these seem to be used mostly in the internal environment.

Project managers interviewed claimed that records dealing with customers were all required to be paper-based. Because, in the South East Asia business environment signatures and seals on the contract are the sole mean to establish their legality. “Traditionally, only the visual and tangible things could convince people” (Interview 9.22).

Moreover, the Senior Manager also mentioned that some financial and accounting information also needed be available in paper-based format. As a global company, subject to regular inspection by the Financial Supervisory Commission of Taiwan, paper-based information proves more convenient to government audit staff and is considered to be the main basis for legal evidence of the business operation.

#### **4.1.4 Management Support for International Standards**

However, top management showed very little understanding of international standards. Before doing the interviews, the standard ISO 90003 and ISO-15489-1 was explained and discussed with the interviewees. Even though it is an international standard on development and maintenance of software, the Senior Manager and Project Managers interviewed did not seem

understand them in detail. Actually, DSC seems to have developed their own procedures for quality control based on these ISO standards, but managers seem to think that “it is not necessary for all the employees to know the international standard. They have their own customary activities to conduct research and design the products” (Interview 2.10).

This combination of paperless office environment and good KM practices is an ideal environment for efficient ERM and protection against litigation. Buy-in and support by top management seems to provide considerable encouragement to employees.

## **4.2 Process**

### **4.2.1 Investigation Phase**

At this phase, Project Managers are the main elements involved in negotiation with customers. This communication is mostly done face to face and in location. Information is obtained on the general background of the customer’s company, customer’s business objectives for purchasing the software product and the scope of the system to be installed. The process is then passed on to the Sales Department for final negotiation, pricing and contracting. It is worth of notice that the Project Manager has no chance to see the initial contract. One of these Project Managers stated that “when the sales department has confirmed the business, they send the additional requirements to me. I need to fulfil the complete requirement specification before they draw up the final contract” (Interview 14.38).

Therefore, once the project is successfully adjudicated and the initial contract signed by both parts, the Project Manager and Systems Analysts visit customer and establish a set of functional and technical specifications, that form the requirement specification for the project. This requirement specification requires the customer’s signature and has equivalent legal power to a contract. In the Senior Manager’s opinion, both the contract and signed customer requirement can “undoubtedly considered as evidence” (Interview 2.45). Nonetheless, email records of negotiations with customer, memos recording and reviewing discussions and other documentation exchanged with the customer during this phase is also kept in the company’s internal records. However, as the Senior Manager acknowledged these documents, often

exchanged with lower ranked employees and system users “without a customer’s signature [customer’s top management], have no legal effect” (Interview 2.48).

In relation to the last point, the Senior Manager gave examples of incidents where requirements had been agreed informally, sometimes even just as verbal agreements. For instance, a Project Manager made a verbal agreement with a customer to provide six functions free of charge and never formally recorded any evidence for this special offer. He then left the company, and the new Project Manager that took over this case, was not able to fully satisfy the customer’s requirements. This created a conflict with the customer that was of very difficult resolution and resulted in losses for DSC.

#### **4.2.2 Analysis Phase**

From the point of view of DSC, the analysis stage aims at establishing system analysis specifications for delivering the agreed product according to the schedule and resources. This specification is usually obtained from the requirement specifications established in the investigation phase and supported by further clarifications from the customer as well as internal experience in the form of past project reports from similar contexts.

These clarifications actually constitute a significant risk and they are often done informally, sometimes over the phone and not always properly documented. For instance, a clarification asked from a stressed manager, whom pressed for time wants to speedily conclude a seemingly inconvenient phone call, may result in incomplete information or even ill-considered acknowledgement. If this clarification is not properly recorded and approval formally requested, then deviations from initial requirements may later on in the project be rejected by the same manager, who may not even remember having given his/hers acknowledgement. Apparently, this is actually a common occurrence in these projects due to the nature of personal relationships and business culture in South East Asia as discussed below in this article. As acknowledged by the Senior Manager, against this type of situation there is no ERM system that can help.

Lesson learned in these past projects are contained in reports stored in a knowledge management system available through DSC's intranet. Each department has its own historical database, and staff from other departments do not always have the right to access this information. As explained by one of the Analysts: "we are the main department researching the project on paperless knowledge management. We could copy the template, and modify some details like the interface, then produce a new specifications" (Interview 15.18). Therefore, past projects provide easy to use and tested templates for both planning and analysis. Overall, DSC uses this knowledge management system for the sharing of past experience and consequently save a lot of time and retaining knowledge that would otherwise be lost due to turn-over of staff.

In addition to the analysis specifications, that is usually sent to the customer for inspection and approval (N.B. signed approval), there are a number of other documents generated at this stage, such as technical documentation, project plans and resource allocation plans.

#### **4.2.3 Design and Implementation Phases**

Curiously, it was when asking interviewees about these stages that the *weltanschauung* of the company became evident. This was made clear by the following statement of one of the Programmers:

"We are a packaged products company, and the packaged management software might not be enough for customers' specific requirements: it is also essential to be dedicated to support of customer software modification. The system analysis specifications will be posted to software engineers, and they need to create designs for structure of the system, programs, user-interfaces, databases, modules and error-handling." (Interview 21.30)

There are two aspects that are important to discuss from this statement. First, system analysis specifications seem to guide design and implementation authoritatively. Second, that the company focuses on adapting their ERP system to needs of diverse customers, rather than produce new SW for each customer.

The first aspect may represent a severe risk, as requirements established often months (if not years) ago, may have changed or even become obsolete. Moreover, interpretation of these requirements may lead to deficient design. One of the Project Managers reported that “it is now generally recognised that there are more findings about defects of design in the phase of implementation. Hence, information on design defects should be recorded for the smooth progress of the working process and preserved as reference for the next design.” This reveals that DSC’s ERM system contains not only the design specifications, but also error notifications associated with these.

The later aspect on the other hand, is non-controversial, has become common practice worldwide and lies at the genesis of the success of multinational ERP vendors such as SAP or ORACLE. This view is reinforced by one of the Project Managers:

“We mainly do the system integration service for the customer. Sometimes, we could use a packaged product to satisfy the customer requirements. Based on the system analysis, we only need to add more functions to the existing products.” (Interview 9.150)

Therefore, there are two main aspects to DSC SW development activities, namely: the customisation of the existing ERP functionalities and the potential development of new features and functions. These, two types of development result in different internal documentation, with the later being much more onerous in terms of detail and documentation.

The implementation activity in itself requires that the code is documented according to precise guidelines for which DSC developed and adapted programming standard. This code documentation standard regulates the format, length and baseline for programmers’ comments on their own code. This is particularly important, as in order to address a shortage of IT professionals in some of the regions where DSC operates, the company often hires industry-specific freelance programmers who are dispatched on-site to ensure customer business continuity. As these are not always available it is important to the company that the code is appropriately documented. This code however is not stored in the ERM system, but in DSC code libraries.

#### **4.2.4 Testing and Installation Phases**

The last steps of the development return to control of the Project Manager who is responsible for the final testing of the ERP customisation, securing the customer's acceptance of the product and training of the users.

This does not seem to be controversial in DSC. One of the Project Managers stated confidently that "because I could understand the requirement specifications in detail, the testing was arranged by me. All the records from implementation will be posted to me from the software engineer" (Interview 10.59). The test specification, test cases and test data are produced in this phase.

DSC Company has two forms of test environment: white box testing and black box testing. The same Project Manager distinguished the concepts as follows: "the white box testing uses an internal perspective of the system to design test cases based on the internal structure, and the black box testing takes an external perspective of the test object to derive test cases" (Interview 10.87). The white box testing was designed for internal employees (e.g. programmers), whereas the black box testing was designed for end-users.

Test results and reports describe the testing process. Errors of design and implementation are identified, described and resolved at this phase. Each test iterations results in a technical records that is kept as evidence for future use. At the end of each test iteration, meetings are held to discuss the errors and disseminate the results and reports. The same Project Manager insisted on "sending the records of errors back to the people with relevant responsibility" to avoid the same mistakes next time.

After white testing, the ERP is installed in the customer's IT infrastructure and black tested. Once, black test is successfully completed, the Project Manager, Analysts and Programmers engage in a training phase. For each component of the training process trainees are asked to fill-in feedback reports, which will be used for learning purposes and improvement of training practice. These feedback forms are usually summarized and processed and result in yet another record in the ERM system. When the training is complete the Project Manager will produce a

training results report which requires the signature of a top manager in the target company to prove that training has taken place.

Finally and as the formal conclusion of the project the Project Managers seeks signature of the customer acceptance document.

#### **4.2.5 Maintenance Phase**

The maintenance phase combines all the previous phases in processes for enhancing the product as requested by the customer. The Project Manager needs to “fix” problems once these have been identified. One of the Programmers stated that “the activities are typically classified into problem resolution, interface modification, and performance improvement. Regardless of the reason for undertaking maintenance, this phase must fully satisfy the customer requirements to the maximum possibility” (Interview 19.73). Some of these maintenance activities are just correction of existing problems, but other imply the development of new customisations or even new features in the ERP system. These later are treated internally as new projects and are documented as such. For the former, the modification of the corrections or modification of customisation are recorded as changes and associated with the initial project. New “modification” records are the produced and stored as evidence.

### **4.3 Technology**

In support of the explicit ERM strategy described above, DSC has created a number of tools to enable and support the desired knowledge-intensive environment. These tools system were encapsulated into a web-based system named EasyFlow that DSC now sells to their customers in addition to using it internally.





Figure 2: Overview of the EasyFlow ERM system.

EasyFlow is composed of 4 main subsystems: Electronic File System, Knowledge Management System, Meeting Tracing System and ISO Document Management System.

#### 4.3.1 The Electronic File System

Electronic File System stores mostly operational and procedural documentation that support the daily run of DSC as business. Examples of documents are requests for holidays, leave of absence, out of hours declaration form, or any other document that require line management approval or signature.

#### 4.3.2 The Knowledge Management System

Knowledge Management System, also known in the company as the knowledge library, is one of the most useful tools of the ERM system. This system is actually the most relevant for this research as it stores all the project and development specific documents, reports and personal experiences. The usefulness of this tool is mostly due to the fact that it is easily available through their intranet and that people can use to communicate internally within the organisation. Employees in the different geographical locations (Taiwan, mainland China and Vietnam) may therefore share experiences about projects in similar sectors or similar organisational cultures. Evidence of this sharing practice was evident in some of the Programmers' statements:

“This system is very useful. I usually post my opinions and minds via this system. There are also some online communities where we are free to ask and talk.” (Interview 20.101)

“There are several online communities in this library. People could log in the relevant community to find knowledge. The knowledge library also has a search engine for people to retrieve required knowledge.” (Interview 18.24)

According to the Senior Manager, the knowledge library is also an important induction and training tool:

“[The knowledge library is] a good place for new employees to become familiar with the operation of the company, since they might meet the same problems and situations in their future work.” (Interview 2.152)

Therefore, the knowledge library, a KS system, is the technological corner stone of the ERM system. It is very successfully operated in DSC and seems to have gained the support of both management and programmers.

#### **4.3.3 The ISO Document Management System**

ISO Document Management System stores all quality assurance related documents, namely those that are required by the ISO standards. Contrary to the knowledge library, it is perceived as bureaucratic system, one that needs to be maintained to ensure certification, but of limited use both in the reality of practice.

#### **4.3.4 The Meeting Tracing System**

The Meeting Tracing System (MTS) may be used to book meeting rooms, store minutes of meeting and store individual's meeting notes. However, to the disappointment of the Senior Manager and Knowledge Manager, who were both heavily involved in the creation of this subsystem, DSC employees only seem to use this system to book the meeting room and make sure they get the exact time and space for their meetings. Typically in high tech environments, analysts and programmers seem to think that the minutes of meeting are taken mostly “for drawing attention to arrangements and issues” (Interview 16.149), and there is no need to

formally store the official records in the system. The Knowledge Manager stressed that “if the relevant people paid more attention to this task, there would be no need to spend more time on recording all the details later when no one remembers what was said” (Interview 16.135).

## **4.4 Culture**

### **4.4.1 East Asian Culture**

According to the ISO 15489-1 (2001: Clause 3.15), records “as evidence” are “in pursuance of legal obligations or in the transaction of business”. However, as several of the Project Managers admitted, systematic recording of every decision and agreements made with customers is very difficult in the East Asian Region. In fact, personal relationship and mutual trust represent an important aspect of success in business in the Region. Consequently, many decisions and agreements are made face to face through verbal contracts, often during of an evening meal at the end of a very hard day of negotiation.

However, verbal contracts are very difficult to prove legally. Without such legal evidence DSC has suffered considerable commercial damage from such verbal agreements on several occasions (i.e. the example mentioned above of the Project Manager that made a special of free features off the record). This has led to the intense effort made by DSC in the development of their ERM policies and system.

Nonetheless, “Verbal agreement is a feature of oriental culture. People insist that buyers and sellers should trust each other, and that agreement made by telephone or oral promise should take effect. And ... the customers of DSC Company are spread right across Taiwan, mainland China, Vietnam, Singapore, Thailand, Malaysia and Indonesia.” (Interview 2.199). This is the main reason why DSC still needs to accept that in order to win certain tenders they still make oral promises. Moreover, and because this same oriental cultural characteristics, DSC rarely resorts to legal action if the conflict with the customer can be resolved by direct negotiation.

In general the DSC believes that only a paper document with a signature and organisational seal can be taken as full proof legal evidence. Their stance is that all other documentation and records stored serve as supporting evidence to contextualise and justify decisions taken, as well as organisational learning materials.

#### **4.4.2 DSC Organisational Culture**

It was evident from the interviews that there was a very good acceptance of the ERM system by both management and programmers, in particular of the knowledge library. This was somewhat surprising, as it widely accepted that analysts and programmers are notorious a neglecting any activity that is unrelated to their primary duties, namely “hate documentation” (Sametinger and Pomberger, 1992; Kramer, 1999; Briand, 2003). Therefore, the situation encountered in DSC was only possible due to the careful promotion of an organisational culture encouraged and supported by top management. This top management buy-in seems to have created a culture of sharing knowledge and experiences. It became apparent that interviewees generally accept the strategy of knowledge sharing and they believe that this sharing of knowledge can save them time in dealing with problems in their daily work. Nonetheless, it became clear that this culture is also supported by an incentive system as well as the good will of the employees. One of the Project Managers expressed this as follows:

“The more experience and views are recorded in the knowledge library, the more bonuses they will get in their personal performance reviews.” Interview 13.52

This was confirmed by one of the Programmers:

“We are required to share knowledge. The more of my knowledge is stored in the ISO records, the more I look good in the personal performance reviews.” Interview 17.41

It is therefore clear that employees are well motivated to create, manage and use electronic records through the EasyFlow system. The measurement of this usage by DSC is largely related to the quantity and quality of the records in storage. In this way the value of and the contributions to knowledge, became manageable and measurable.

## 5. Conclusions

The case-study presented in this paper emerged as an example where ERM, KS and KM are conjugated in practice. The knowledge library presented is a good example of an ERM system that was conceived, designed, implemented in-house to support KS and KM, as well as serving as a legal defence against litigation. In fact, the use of ERM not only supports the very difficult processes of externalization of individual's tacit knowledge, but also brought some unexpected benefits. It enabled the establishment of a clear and well understood system of reward for employees, a productive process of organizational learning, as well as the establishment of a culture of careful documentation of contacts with the customer. Finally, the ERM system enabled management and employees to understand the value added of knowledge sharing.

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