

CO-DESIGN OF AN ADAPTABLE SYSTEM FOR INFORMATION MANAGEMENT

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Abstract: Information management is a discipline dealing with creation, communication, utilisation and disposal of information. In the 21st century, the volume of information forces the organisations not only to have formal processes for information management, but also employing effective IT systems to leverage the value of information. This paper introduces a method for improving the process of information management and co-design the business process and IT system to support the information management practice in organisations. This method takes into account stakeholders' roles and responsibilities, and their needs for information provided by the information management processes. Adopting organisational semiotics as theoretical and methodological foundation, the IT system designed will be adaptable to the changes of requirements due to the changes of the business environment and stakeholders' interest.

1 INTRODUCTION

In today's business environment, many organisations regard information as asset (Best, 1996; Burk and Horton, 1988; Owens *et al.* 1997; Nicolls, 2002; Mathkour *et al.* 2005; Abdul Karim and Hussein, 2008; Yassine and Shirmohammadi, 2008, Blazic and Saljic, 2010). Examining closely, it can be found that most of the organisation are not able to manage this asset in the way as other types to maximise the value of information. The lack of effective methods and techniques for capturing, storing, using and disposal of the information has constrained the organisations to benefit to the full potential. A need for standards, policies and techniques is clearly felt which should be able to support the organisations to make strategic decisions and perform business operations (Ladley, 2010).

Some organisations have some standards and even procedures to apply manually. But the challenging issue still remains in that a large volume of information overloads on the users and information system and technological support are not capable of selecting and supplying relevant information at the right time to the right users. Some organisations suffer from insufficient control of quality and processes in information management activities. This leads to a number of risks, e.g. (i) not

knowing where the information is, who is accountable for the quality of information, who has access to that information; (ii) incompliance with regulatory policies because of improper procedures for retention and disposal of information. In addition, knowledge and expertise cannot be shared among different parts of the organisation due to the lack of proper communication channels. Therefore, organisations are not able to react to internal and external forces and make agile decisions based on required information.

One solution is to design the system of business processes of information management and the IT system to support information management activities at the same time. In other words, a proper information management process should consider the business system and IT system as one integral unit (Liu *et al.* 2002). Therefore, they should be designed together and evolve seamlessly.

In this paper, the co-design of business and IT is described as a cross organisational processes in which people are involved from different parts of the organisation. The co-design is seen as a continuous process and a change in the system can be introduced when there are changes in information management processes. The rest of the paper is organised as follows: a brief background on information management (IM) and organisational

semiotics (OS) are presented in section two and three respectively. Then, a co-design method for an adaptable information system is discussed in section four, followed by its application in section five. Finally, the validity of the method is discussed in section six and paper is concluded in section seven.

2 MANAGING INFORMATION AS A CORPORATE ASSET

Information is one of the important corporate assets. It is essential that it is managed efficiently to meet business needs and comply with internal policies and external regulatory requirements. Information management is a process which helps to achieve this goal. Academically, IM is also a discipline which is concerned with capturing, storing, organising, structuring and processing relevant information accurately and timely from many sources as well as delivering or publishing it to relevant audience to be used to realise their objectives (Newman and Logan, 2008).

The AIIM community introduces a set of guiding principles for information management (AIIM, 2010), including (1) *information is corporate assets* and the principles of IM should be agreed across the organisation; (2) *Information must be made available and shared* by relevant people; (3) The retention and archiving information is managed corporately; (4) Senior management involvement as well as front line workers is necessary as IM is a corporate responsibility. The guidelines also state the importance of employee education and training to achieve better IM practices.

However, this is not the case in many organisations. Many do not have proper IM policies and procedures and have not paid sufficient attention. This may lead to some undesired consequences. These are some examples to illustrate such consequences. First, some companies, according to regulatory authorities in their sectors, are obliged to keep employees' records for more than twenty years. If the company did not have proper retention policies of employees' records, they would not be able to produce defensible records and evidences in the event of litigation. Therefore, they would fail to comply with the regulatory requirements and high legal discovery costs might be incurred to the organisation. Secondly, as a result of improper (or lack of) IM practice, required information may not be shared among different parts of the organisation. This may lead to a number of

problems; such as, no collaboration among people and no sharing of information and knowledge in different sections. Finally, although some organisations have basic infrastructure and practice for IM; the lack of effective IM processes would not lead the realisation of the full value of the infrastructure. For example, in our case studies, we found that a company bought Sharepoint 2010 but without configuring it properly to fit into its IM processes these problems can be solved by a proper IM practice with the support of an IT system.

Many technical systems are available and have been adopted in industrial practice; for example, Microsoft SharePoint, Open Text Document management System (eDoc), Oracle Enterprise Content Management (ECM), IBM Document Manager, and Autonomy Record Manager. Acquiring the best IM IT system requires an understanding of the IM practice in the organisation if a close fit is expected; while the maximum value from such as technical system requires carefully analysis and alignment of IT system functions and IM processes in the organisation. Therefore the organisations' processes and activities should be analysed before a proper IT system is bought or developed in-house. In a survey carried out by IDC, the fit between business and IT is mentioned as the highest priority from business managers' view (Ortis and Pallares, 2007)

. This provides a key motivation to our work in the co-design of business and IT systems. The co-design will also address some of the other issues (Figure 1).

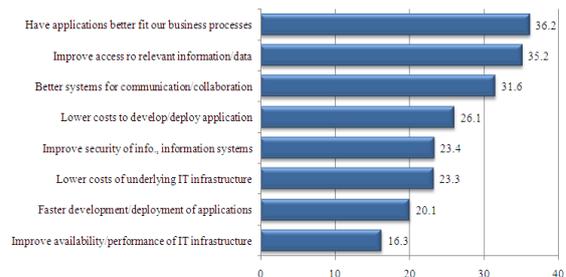


Figure 1: IM priority activities (Ortis and Pallares, 2007).

3 SEMIOTIC ANALYSIS OF INFORMATION MANAGEMENT

Organisational Semiotics (OS), the study of signs related to organisations, facilitates designing an integrated system and related processes to support

IM by considering an organisation as an information system (Stamper, 1992). OS will shed light on the use of information as a sign and its relation to objects through interpretations made by actors. Based on OS, organisations are information systems in which information is created, processed, stored, used and presented (Liu *et al.*, 2002). From a semiotic perspective, an organisation is a multi-layered system in which IM activities take place in all three spheres in the “organisational onion” (Figure 2).

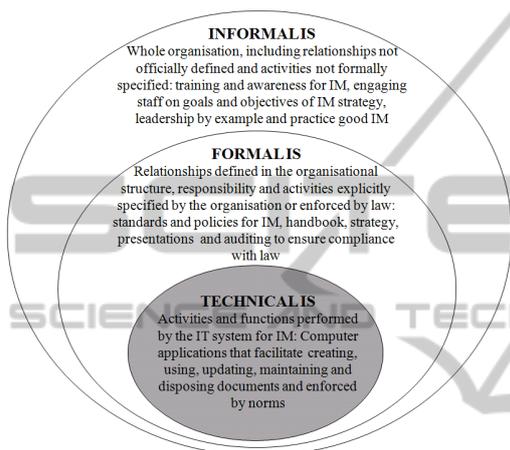


Figure 2: IM activities in three spheres in the “organisational onion”.

Informal Layer. Whole organisation, including relationships not officially defined and activities not formally specified; e.g. training and awareness is crucial for effective information management. Leadership team must also practice and support good IM. This leads to a culture of managing information over time in the organisation and provides suitable environment for this purpose.

Formal Layer. Relationships defined in the organisational structure, responsibility and activities explicitly specified by the organisation or enforced by law. IM practice in each organisation must comply with the standards and policies imposed by the regulatory bodies or governing organisations. In addition, “best practice” emerged through past experiences offers a useful reference model for IM processes and the functions of the technical system.

Technical Layer. Activities and functions performed by the IT system for information management. Those patterns of practice and knowledge of IM must be captured and incorporated into the design of IM processes and relevant IT system.

Knowledge and practice of IM can be captured

and analysed with the Norm Analysis Method (NAM) (Liu, 2000). NAM treats patterns of behavior and business knowledge as norms which govern people’s actions. Identifying the norms will enable us to understand and model the IM practice in the organisation.

The general form for specifying a norm is as follows (Liu, 2000):

*Whenever <context>
if <state>
then <agent>
is <deontic operator> to <action>.*

The <context> refers to the situation while the <state> shows the conditions. The <agent> is the actor which this norm is applied to. The <deontic operator> can be obliged, permitted or prohibited. The <action> is the behaviour that the specified agent should carry out. For example, consider this rule: all online shopping can be returned within 14 days. This can be specified in a norm as follows:

*whenever a person shopped online,
if within 14 days of shopping,
then the purchaser is
permitted to return the item.*

Analysing norms in this way brings more flexibility into the system since norms capture patterns of behaviour and are attached to system functions; therefore, changes in one of these (norms or system functions) will not affect the other. Few methods provide guideline on analysing norms and most methods assume to hard code them at the end; therefore, any changes in business rules may end up with changing the coding and in some cases even rewriting the software. NAM helps to prevent this kind of disastrous situations. More information on NAM can be found in (Salter and Liu, 2002). An OS motivated method for IM helps organisations solve mentioned issues and achieve competitive advantages through proper information management.

4 A METHOD FOR THE CO-DESIGN OF BUSINESS AND IT SYSTEMS

Alignment of business and IT systems has been seen an important challenge to be faced by the industry and researchers (Thevenet and Salinesi, 2007). Integration between business processes and IT functions in IM has been an ambition to many. As Ladley (2010) stated: “*separation of IM from business processes must become [a] historical artefact*”.

Co-design is the process that addresses this problem and tries to solve the issue by encouraging analysts to concentrate on the organisational and technical design issues concurrently. Co-design should be a continuous process to make sure that IT systems and business processes are effectively co-aligned.

The model for co-design (Figure 3) is an extension of the work of Liu *et al.* (Liu *et al.*, 2002) with reference to other recent research in other relevant fields, particularly soft systems methodology (SSM) (Checkland and Scholes, 1990) and organisational semiotics (e.g. organisational onion) (Liu, 2000). In this model, an organisation is presented in three layered information system, informal-formal-technical, and tasks to be performed in each layer are explained subsequently.

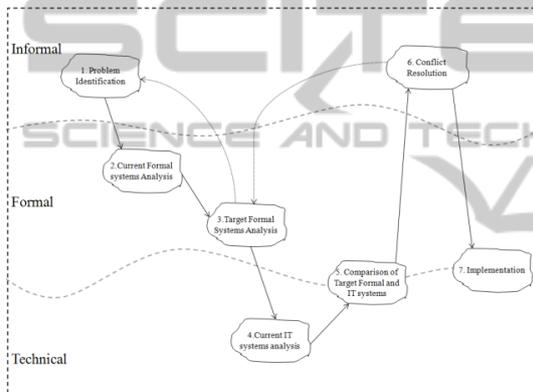


Figure 3: Dynamic co-design of business-IT systems.

Phase 1. Problem identification: The aim of this phase is to identify an existing problem and formulate it in a structured way to be investigated and solved. The rationale behind this phase is that, for the same problem, individuals see different symptoms, but they do not understand the root cause of these symptoms. Therefore, knowledge from different domains of an organisation should be gathered to find the main problem.

Phase 2. Current Formal System Analysis: This phase involves identifying involved business processes and activities related to the problem.

Phase 3. Target Formal System Analysis: This phase represents the target situation in the organisation. Desired changes should be applied to the business processes determined at the second phase.

Phase 4. Current IT System Analysis: The current technical system should be analysed as well. This phase includes two main activities:

1. Identifying applications and related IT systems (entities)

2. Identifying the structure of the database currently working in the organisation.

Phase 5. Comparison of Target Formal and IT systems: The target model of the organisation shows the desired situation which IT should support. Therefore, a comparison should be made between the target model and IT systems to find that which parts of IT systems need to be changed to support changes in business effectively and efficiently. For this purpose, followings should be identified:

1. The processes which are automated into machine will be identified and shown to what extent they are automated into IT systems.
2. Norms and business entities that should be supported by IT.

Phase 6. Conflict Resolution: The aim is to validate changes and whether they can be implemented or not. Until this phase, all the required changes in formal layer (phase 4) and technical layer (phase 5) are identified; however, there are some issues, such as, conflicts, interactions and overlap between informal, formal and technical layers and should be studied carefully.

Phase 7. Implementation: The outcome of phase 6 will determine which identified changes are affordable for the organisation. Therefore, an action will be taken to apply changes as simultaneously as possible in both formal and technical layers.

The dynamic model for co-design proposed here shows an organisation in three layers surrounded by dash lines, because modern organisation do not have defined borders which separate them from their environment. This argument has been justified in Daft (2007) although the same author specified solid border as one of the main elements of an organisation in Daft (1998) (Daft, 1998; Daft, 2007). In addition, the border between different layers is not defined either. That is why dashed lines are put to separate layers from each other.

The loop between phases 1 - 3 is to address the complexity of the problem and due to the consideration that there may not be a single and straight answer to the problem. The negotiation between stakeholders and the changes made will hopefully result in a more promising solution to the problem in hand.

The main outcome of the co-design model is an adaptable information system which is responsive to business needs. By applying this model, business processes and IT systems are designed as one integral unit and can interact effectively to support business needs and decisions. Such a system will bring competitive advantages. In summary, the model for co-design aims to overcome the limitation

of current methods. The proposed model will be evaluated through using a case study and its benefits and validity will also be justified through its application.

5 THE CO-DESIGN METHOD IN ACTION

In the previous section, the proposed method and its theoretical benefits has been discussed. Here, we demonstrate its practice and application in a real world situation. The case study is based on the practice in a large British shipping company. This company is well established and has a defined structure for every department. However, they have many problems for managing information, documents and contents as they consider IM as part of each department rather than a universal section on its own.

The company introduced the notion of controlled document, referring to those which should be created, stored, updated and published to related audiences. Each control document has a set of controls, such as document owner, approver (who approves the content) and revision history shown in front or back of the document in addition to page number, ID, status (draft or obsolete) and date/number displayed in all pages. All the documents should be recorded in the controlled document register by relevant document controller role. Every registry includes the owner, approver and next review date. All these policies in place, yet the company is still struggling with the overload of information and maintaining controlled document lifecycle.

Phase 1. Having the proposed model in mind, the problem identification step seeks to find the root of the problem described by different people who see different symptoms and look for different solutions. As a result of communication and brainstorming sessions inside the organisation, the analyst will realise the root problem which causes different symptoms. This phase might have a standard pattern of sessions, but the whole process is highly informal. Moreover, there is no straight answer to the problems identified and experience of analysts and stakeholders involved in this stage has an effect on the quality of the solution.

Phase 2. By articulating the problem, all the processes and activities related to the controlled document practice will be analysed to understand which of them lead to the problem and should be removed, changed or improved. In addition, business

rules related to each activity will be studied in this phase to specify the expected behaviour of agents, either human or computer, performing the action. Figure 4 shows the concise version of the document management processes using use case diagram in which every use-case contains a set of activities, two of which, 'distribute document' and 'dispose document', are investigated closely.

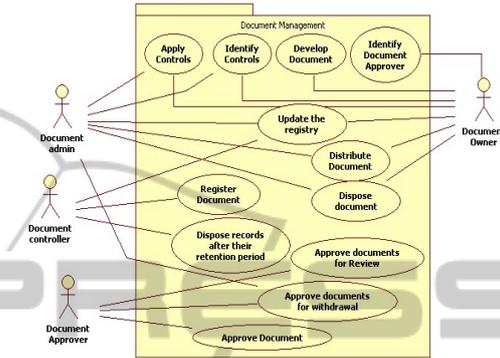


Figure 4: Document management use case diagram *Distribute Document Process*.

The current activities of distribute process are shown in figure 5. Several issues can be addressed in this activity diagram. For example, the activity to "put the main copy in the safe place" is not defined based on the fact that a "safe place" can differ for each person; personal computer, company email, personal email and etc.. Moreover, when interviewing related people in the organisation, nobody could define who is authorised to identify the audience of a document and who controls the distribution. In other words, it is not clear who is responsible for the distribution of information to the unauthorised audiences.

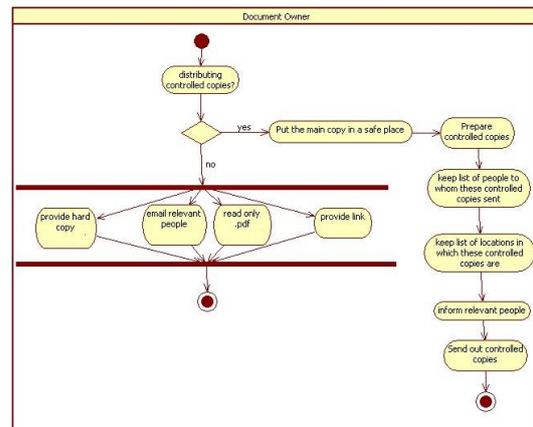


Figure 5: 'Distribute document' activity diagram *Dispose Document Process*.

The disposal process is presented in figure 6 and entails some issues; there is almost no action for informing audience about the disposal of a document and no clear job description for “Document Admin”. It is always mentioned that document admin liaise with others to handle the disposal of document but who disposes it and what exactly is document admin's job. In addition, responsibilities of a document controller can be carried out by a computer agent without any need for communication or liaison between document admin and document controller.

To specify the business rules, NAM is used as explained in previous section. Considering “dispose document” activity diagram (figure 6) an example of written business norm in which document approver should control disposal of a document is:

Whenever a controlled document exists, if it is no longer applicable or needed, then the document owner is obliged to consult the admin about its withdrawal.

This way of writing norms is readable and understandable for both business and technical people and can be easily transferred to the programmer for coding if a new IT system is needed to be written.

Any of these problems and many more that has not been mentioned affect the day to day job of the organisational and make it less efficient and productive. Therefore, they should be studied well and improved.

Phase 3. As a result of the analysis of all processes and activities, some improvements are proposed and a new process model is proposed. The roles of the document admin and document

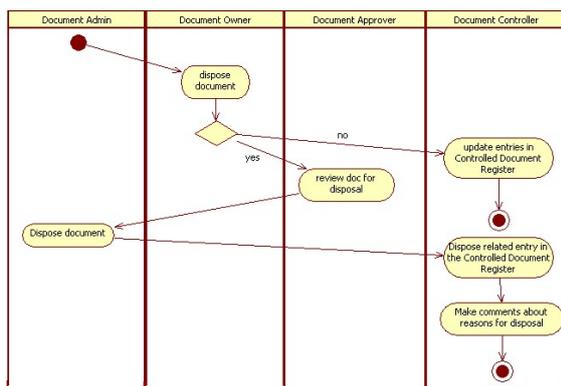


Figure 6: ‘Dispose document’ activity diagram.

controller were blurred and can be delegated to other roles or automated. The new proposed process

model is presented in figure 7. Document admin and controller are removed and the job of registering documents is delegated to the document owner. In fact, document registering activity will be automated and an IT system will handle it on behalf of document owner. Problems in activity diagram can also be addressed and the related changes be reflected both in activity diagrams and norms.

Phase 4. After detailed analysis of processes and activities, target ones are proposed. Now this is the time to see whether the current IT system can support these changes or not. Two main questions should be answered in this phase: (i) what information for carrying out and controlling activities is being captured and processed by IT system and (ii) which IT applications support which processes identified in phase 2 and to what extent.

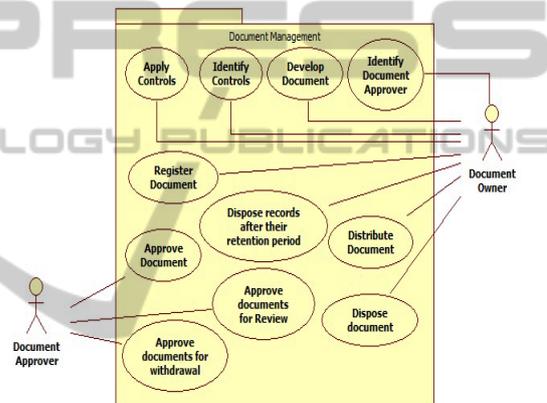


Figure 7: Improved document management processes.

In our case, the company has already had an IT system to support the IM process even though the IT system itself made everything more complicated. It might have been helpful someday, but as a result of several changes in business processes and not reflecting them in the IT system. It has become the bottleneck to the business.

Phase 5. As a result of analysis of the target process and activities and comparing with current IT system, a target IT system is put forward. Semantic analysis method (SAM), one of organisational semiotics methods, is used here for data modelling (Liu, 2000). Ontology charts are the output of SAM. An ontology chart is drawn from left to right while the existence of right nodes (dependents) is dependent on left nodes (antecedents). For example, for an employment to exist there must be a person and a company. Role names are written on the line to clarify each side in relationships (figure 8).

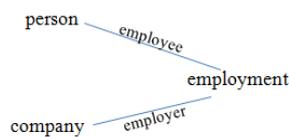


Figure 8: Sample ontology chart.

A simplified version of the data model, one of ontology charts, is presented here as a case in point (figure 9). The shipping company is accompanied by a # sign to show it is one of the companies that we keep track of their information. So, if in the future the company is extended or split into two companies, there is no need to redo the IT system. Moreover, the list of all document audiences is worked out by the shipping company related authority and document owner should not be concerned with it. He will publish it to the related people as shown in the fig. 9. The result of SAM can act as a database schema which captures necessary and quality data as mentioned in (Jiang *et al.*, 2009) “*the schema of a database plays a significant role in ensuring quality of data in the database*”. Such a database is stable and acts as base for the IT system.

In figure 9, terms written on the lines are role names. Role names (or labels) exist because of an association between two entities. For example, document audience is an employee (a person who has an employment contract with a company) to whom a document is related. Moreover, a document is only published to related audiences and, in the case of disposal of the document, only related audiences will be informed.

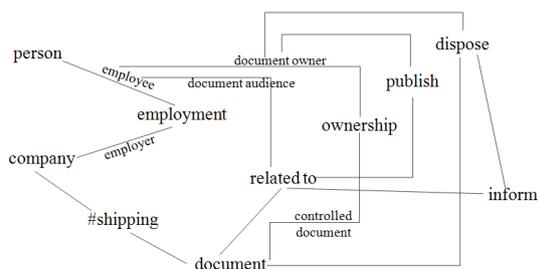


Figure 9: A current data model supporting the IT system.

The proposed IT system can be bespoke or an off-the-shelf package. For the shipping company, a package application was proposed and configured carefully to the need of the business; the ontology chart has been applied easily and the problems of which some discussed here have been addressed.

Phase 6. Related stakeholders were involved in a series of discussions and meetings to come to an agreement and, as mentioned in the model, the

conflict resolution stage led to an agreement on the solution followed by the full implementation in phase 7. It should be emphasised that the analyst played a key role in the conflict resolution stage. The result of the applicability of the proposed method and solutions are discussed in the next section.

6 VALIDITY OF THE METHOD FOR IS DESIGN

The organisational semiotics realm regards organisations as information systems. Long before the existence of technology, there were organisation, human interactions and needed information was captured with other means (Beynon-Davis, 2009). We tend to follow the same principle and consider organisations as information systems with three layers; the classification of “informal-formal-technical” provides analysts with a better view of who should be contacted and what should be studied. Those tasks put in the informal layer are concerned with human interaction, organisational culture, employees view towards changes and etc. Consequently, tasks in the formal layer include studying the organisation including human interactions, but repetitiveness and predictability are main features of actions in this layer. Finally, in the technical layer, the main concern is the automation of the business processes and the interaction with machine. This distinction organises the analysts’ mentality and helps through the process of co-design.

A well defined design method must have three main elements (Buede, 2009); (i) a good view of organisation’s processes along with activities performed in each process, (ii) business rules which control these activities, and (iii) an information system to capture and feed the necessary information for carrying out activities. The proposed co-design method includes these elements and the applicability has been discussed in detail in section 5. In other words, use case and activity diagrams are familiar methods in business practice and help to obtain a clear view of current states of an organisation and facilitate communication among different people to reach an agreement for the desired state. This shows that the proposed co-design method has the first main element of a well defined design practice. The ontology chart resulted from SAM is a conceptual model of information needed to be captured. This model can later on be transformed into database to form an integral information system.

Since business rules are identified in a way that it is readable by human and machine and it is specified that which rules are related to which activity and which agent is carrying out that activity, any changes in these rules can be reflected immediately. In addition, Database designed based on ontology chart is immune from redesign, and extendable to adapt to future changes in activities.

In conclusion the advantages of proposed tools and techniques are to make the co-design process flexible enough to be adaptable to changes. In other words, it will be able to adapt and adjust to future needs. Therefore, the co-design model is well-defined, adaptable and extendable, and helps organisation to manage problems and changes effectively as it did for the shipping company.

7 CONCLUSIONS

That “information is an asset” is a common statement. Therefore it should be better managed. Although this makes sense, it does not get the information management activities funded. Although the first step to have a good information management is to standardise its activities, a good IT system should be employed due to the overload of information. In this paper, we proposed a co-design method which helps to design a better information management practice by involving people from different disciplines aligned with IT systems. A shipping company is examined as a case study and findings are discussed. Adopted tools and techniques in the co-design model are industry standardised; it makes the co-design model easily applicable and users can spend time on main and new principles instead of learning new techniques. This also facilitates communications of concerns and objectives. As a result of several follow up interviews with related stakeholders, the benefits of employed system identified and brought here.

Future work includes extending the norm analysis to provide a formal procedure for capturing communications and norms. In addition, the problem identification and conflict resolution stages, which are quite informal and does not have strict structure, needs further research regarding cultural, social, and individual behaviour towards change; due to the fact that the proposed changes might cause resistance against change or alter the change process since individuals have their own agendas.

REFERENCES

- Abdul Karim, N. S., Hussein, R., 2008. Managers' perception of information management and the role of information and knowledge managers: The Malaysian perspectives. *International Journal of Information Management*, 28:2. 114-127 .
- AIIM: Association for Information and Image Management. Retrieved 10 15, 2010, Association for Information and Image Management (2010).
- Best, D. E., 1996. *The Fourth Resource: Information and Its Management*. Aldershot, Hants: Aslib/Gower.
- Beynon-Davis, P., 2009. Significant threads: The nature of data. *International Journal of Information Management*, 29:3, June 2009, pp 170-188.
- Blazic, A. J., Saljic, S., 2010. Confidentiality Labeling Using Structured Data Types. *Fourth International Conference on Digital Society*.
- Burk, C. F., Horton, F. W., 1988. *Infomap: A Complete Guide to Discovering Corporate Information Resources*. Englewood Cliffs, NJ: Prentice Hall.
- Buede, D. M., 2009. *The engineering design of systems: models and methods*, 2nd edition, Wiley-Blackwell.
- Checkland, P., Scholes, J., 1990. *Soft Systems Methodology In Action*. Chichester, West Sussex, England.: John Wiley & Sons Ltd, Baffins Lane.
- Daft, R. L., 2007. *Organization Theory and Design*. Hampshire, UK: South Western Educational Publishing.
- Daft, R. L., 1998. *Organization Theory and Design*. the University of Michigan, USA: South-Western College Publishing.
- Jiang, L., Barone, D., Borgida, A., Mylopoulos, J., 2009. Measuring and Comparing Effectiveness of Data Quality Techniques, *proceeding of The 21st International Conference on Advanced Information Systems Engineering (CAiSE'09)*, pp. 171–185, Amsterdam, The Netherlands.
- Ladley, J., 2010. Making Enterprise Information Management (EIM) Work for Business: A Guide to Understanding Information as an Asset. *Elsevier Science & Technology*.
- Liu, K., Sun, L., Bennett, K., 2002. Co-Design of Business and IT Systems. *Information Systems Frontiers*, 4:3, pp 251-256.
- Liu, K., 2000. *Semiotics in Information Systems Engineering*. Cambridge University Press, UK.
- Mathkour, H., Touir, A., Al-Sanie, W., 2005. Automatic Information Classifier Using Rhetorical Structure Theory. *Advances in Soft Computing: Intelligent Information Processing and Web Mining*, pp. 31: 229-236.
- Newman, D., Logan, D., 2008. Gartner Introduces the EIM Maturity Model. Gartner, Inc.
- Nicolls, W., 2002. *Implementing Company Classification Policy with the S/MIME Security Label*. RFC 3114.
- Ortis, I., Pallares, A., 2007. *Retail/Wholesale, Industry-Specific Applications Investment Plans*. International Data Corporation (IDC).
- Owens, I., Wilson, T. D., Abell, A., 1997. Information and business performance: a study of information systems

- and services in high performing companies. *Journal of Librarianship and Information Science*, 29:19-28.
- Salter, A., Liu, K., 2002. Using Semantic Analysis and Norm Analysis to Model Organisations. *Proceedings of the 4th International Conference on Enterprise Information Systems*, (pp. 847-850). Ciudad Real, Spain.
- Stamper, R. K., 1992. Language and Computer in Organized Behaviour. In van de Riet R. P., Meersman R. (eds.), *Linguistics instruments in knowledge Engineering*. Elsevier Science, Amsterdam, 143-63.
- Thevenet, L. H., Salinesi, C., 2007, Aligning IS to organization's strategy: The instalmethod. In: *proceeding of The 19th International Conference on Advanced Information Systems Engineering (CAiSE'07)*, 203-217.
- Yassine, A., Shirmohammadi, S., 2008. Privacy and the market for private data: A negotiation model to capitalize on private data. *IEEE/ACS International Conference on Computer Systems and Applications (AICCSA 2008)*, pp. 669-678.

