Computer Aided Tool Support (CATS) for Information Strategy Planning (ISP): Generating Application Portfolio for Business Area Analysis

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ABSTRACT

Information Strategy Planning (ISP) is concerned with an organization's plan to acquire appropriate "IT blueprint" encompassing suitable hardware, software and telecommunication facilities for the utilization of applications required by the business with adequate support structure. The purpose is to determine the enterprise's business goals and a high-level overview of the enterprise, its functions, data and information needs. This research builds an ISP engine, i.e. the Computer Aided Tool Support (CATS) that has the capability to generate application portfolios that can support the business strategy of the enterprise. Application portfolio is a major part of the ISP deliverables which can significantly aid in formulating suitable strategies for IT supply and IT support structure. CATS will help to facilitate End-User Computing as a tool not only to ease end-users in planning for their IT adoption, but also to ensure that their IT investment is aligned to business goals and strategies. CATS will be able to help the Small Medium Enterprise (SME) companies and other organizations in their information systems planning so that they can achieve their missions and objectives in more efficient way.

Keywords

Information Strategic Planning (ISP), Computer Aided Tool Support (CATS), Application Portfolio, Small Medium Enterprise (SME)

1.0 INTRODUCTION

Realizing the importance of an ISP for the organization, top management should consider conducting an ISP in order to ensure that its IT investment supports the organization's business requirements and strategies. This paper describes the development of a web based prototype tool that can model the information requirements of the enterprise and supports its business mission, goals, and strategies.

Deliverables of ISP would include a suite of application portfolio and potential business areas, formation of corporate databases, technical environment including hardware, software and networking, and organization of the enterprise's information systems.

This study intends to assist Small Medium Enterprises (SMEs) in their planning for IT adoption. Without proper ISP organization will face difficulties in ensuring adequate return in their IT investment. On the other hand to carry out an ISP study would require high cost to be borne by the organization. Furthermore, for a small medium industry, due to its size and financial capabilities, managers do not have the time and resources to implement a complete ISP. To facilitate the process, several Computer Aided Software Engineering (CASE) tools in the marketplace can be used to automate the ISP process thereby reducing the time taken to complete the ISP. However, these tools are extremely expensive and would require consultants that are not within the means of SMEs.

In order to address the above mention problems, a prototype tool support has been developed that model the information and process requirements of the enterprise. The prototype tool was applied in selected cases to generate application portfolios.

2.0 LITERATURE REVIEW

Information Strategic Planning (ISP) has been described as a system comprised of inputs,

processing and outputs (Ang, Shaw, and Pavri, 1995), (King, 1988) and the purpose of ISP is to create a plan of recommendations that fulfill management objectives and thus benefit the organization (Raghunathan and Raghunathan, 1994), (Segars, 1994). It also includes the specification of databases and systems to support those applications (Hartono, Lederer, Sethi, and Zhuang, 2003).

According to Blumenthal (1969) the need for ISP was recognized as early as 1969 and the benefits of formalized ISP have been documented. Planning involves setting objectives and policies to enable an organization or department to deploy its resources effectively and efficiency to achieve its goals (Drucker, 1979). Drucker (1979) also said that the act of planning requires making risk-taking decisions at the present time with the best possible knowledge of their outcomes. Clearly, without planning it is very difficult to achieve anything at all. Cash, Macfarlan, and McKenney, (1988) found that ISP offers information intensive industries greater opportunity for strategic benefits.

An application portfolio is very important aspect to manage in organization to meet management goal and strategies for customer and shareholders value (Weill, and Broadbent, 1998). Application portfolio models provide the means for balancing the portfolio and the life cycle of the information systems. They also provide the management approaches to meet the goals of the enterprise and to create the maximum benefit.

Using ISP, the process of identifying a portfolio of computer-based applications that will assist an organization in executing its business plans and realizing its business goals can be done (Hartono, Lederer, Sethi, and Zhuang, 2003).

To ease the ISP process, several CASE tools has been introduced by several vendors such as AllFusion:Gen (formerly known as COOL:Gen) by Computer Associates International, Inc. (CA) and Application Development Workbench (ADW) by KnowledgeWare. AllFusion:Gen provides a proven development environment for designing, deploying and maintaining high-performance enterprise application. Using AllFusion:Gen developers can rapidly produce complex e-Business application that meet changing requirements (CA, 2007). ADW is a large tool set for information engineering. ADW tools are grouped according to Information Engineering (IE) stages into for subsets called workstations: Planning workstation, analysis workstation, design workstation and construction workstation. However, these tools are extremely expensive and would require consultants to use them (KnowledgeWare inc., 1994).

This study introduces a web-based Computer Aided Tool Support (CATS) that can generate application portfolio applicable to SMEs. As Zulkhairi (2005) discussed that there are two ways in generating application portfolio i.e. best guess and cluster analysis, this tool is developed using cluster analysis. According to Zulkhairi (2005), the technique of best guest groups the entity types together according to the processes and functions to generate the application portfolio while cluster analysis used affinity algorithm in generating the application portfolio. Affinity algorithm has been used in various applications for metric clustering purposes. Liu, Zhang, Chen, Lyu, & Ma (2004) used affinity ranks to improved information retrieval performance based on two proposed evaluation metrics, diversity and information richness. Zhang et al (2005) proposed affinity rank to re-rank search results by optimizing two metrics (diversity and information richness) to improved web search results. For this study affinity algorithm is used to optimize two metrics which are functional model and data model.

3.0 DEVELOPMENT

The CATS prototype was developed on a web-based environment using Active Server Page (ASP) 3.0 as the development environment and Microsoft Access as the database that forms the repository to capture the data and process models. The idea of a web-based platform is to facilitate group work and ease of communicating the requirements and models generated by the prototype to members of the workgroup or users.

The core of the design is building up of the affinity analysis engine. Since this is prototype system, the design of the user interface will be simplified, however the logic of the affinity analysis algorithm is complete. Figures 1 through 4 show the systems architecture of the CATS for ISP. Each user representing an organization will be assigned a separate user account to build their enterprise information model separately. Two main components of the architecture in which the user can access are the Organization Chart planning object and the Subject Area planning object as in figures 2 and 3. The Organization Chart planning object forms the basis for the Business Function and Process model, whilst the Subject Area planning object will be used to create entities that are of interest to the organization. Users will be most familiar with their own organization structure, therefore providing them with the facility to model their business based on the organization chart would produce an accurate business function and process models. After the user has entered information regarding the organization structure and subject area

that is of interest to the organization, the prototype will then transform this information into a first-cut initial functional model, and a data (entity) model, respectively. This is also known as the Initial Enterprise Information Model, which is the first phase of the prototype function. To aid the user with the initial models, a baseline functions and subject areas are supplied that represent typical business functions and information requirements. The user may choose to select the objects appropriate for the business and may also drop objects not relevant to the business.
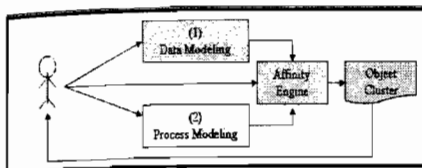

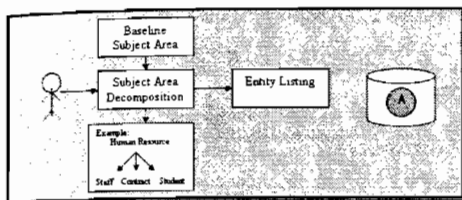*Figure 1: Basic system architecture*
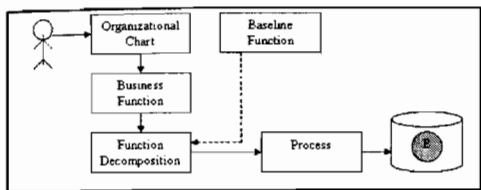

Figure 2: Data modeling architecture

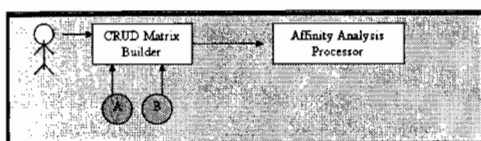*Figure 3: Process modeling architecture*

Figure 4: CRUD and affinity

The second phase of the prototype function involved the creation of the Refined Enterprise Information Model. The initial functional and data models will then be accessed by the user(s) to refine them further into sufficient level of details. To achieve this, the prototype provides a hierarchical representation of the information where the user can break down information into finer details. This can be an iterative process, where users can store and retrieve the model repeatedly, go through with other users until they are satisfied with the accuracy of the model representing the organization's requirements.

The final version of the model will then become the refined enterprise information model, ready to be analyzed in the next phase.

The third phase of the prototype function is to make an analysis of the relationship between a given business function or process to a corresponding entity. The idea is to examine the type of business operation that a given function or process is capable of acting upon on a particular entity or piece of information. An activity (function or process) can act upon a data (entity) in one or combinations of four operations: Create, Read, Update, and/or Delete. Thus a matrix known as the CRUD (short form for Create, Read, Update, Delete) will be generated by the prototype associating the list of business functions (or processes) with the list of entities supplied by the users in the first two phases as shown in Figure 4. This will be a highly interactive session whereby the users will be examining every piece of information relating a particular business function (or process) with its corresponding entity. For every pair of function-entity association, the user will have to base on business sense to make up the operation that can be acted upon for that particular function to its corresponding entity pair. For example, the function Recruit Personnel and the entity Staff will have the operation Create associated with them since in Recruit Personnel a major activity is to hire new staff and create a record of the new staff in the organization's database. Therefore, the user will interact with the CRUD matrix by entering "C" (or clicking the value "C" in the pull down menu) in the cell that forms the intersection between Recruit Staff and Staff in this example. The operation is repeated for all function-entity pair, skipping those pairs that make no business sense to be associated by leaving blanks to those cells.

The fourth and final phase of the prototype function involves very minimal user intervention but highly intensified, number crunching computerization involving complex and sophisticated algorithm. This is the Affinity Analysis engine. In this study development of the Affinity Analysis engine is based on the principle of Cluster Analysis. This technique is based on the same CRUD Matrix as mentioned before, but using certain mathematical formula to cluster closely coupled entities based on their associations with the corresponding functions (or processes). Again, as in the previous example, the "C" in each cell of the CRUD matrix is used to determine whether common relationship exists between entities being created by a function or process. A relationship between a function and an entity exists if the process uses (or creates) the entity in its execution. These relationships are recorded in the cells of the CRUD matrix mentioned

earlier. The common relationship between entities is determined using factor analysis based on pair-wise comparison between entities. Factor analysis is a tedious process involving large number of calculations, particularly when deciding whether an entity should belong to an existing cluster as this will involve calculations of weighted average to determine the degree of "closeness" of the entity to the existing cluster. For this reason, an Entity Clustering Algorithm is built to automate the affinity analysis process which forms the core of the Affinity Analysis engine.

The algorithm computes Affinity Factors, which represents the proportion of the number of functions using a pair of entities out of the number of functions using one element of the pair. For example let E_1, E_2, E_3,....., E_m be the entities and F_1, F_2, F_3,....., F_n be the functions in the M-by-N matrix. The Entity Clustering algorithm can examine every function and calculates (1) the number of functions using a given entity E_1, say; (2) the number of functions using the entity pair E_1 and E_k where k is between 1 and m inclusive and k $\neq$ 1. Hence, let

$F(E_1)$ = number of functions using E_1.
$F(E_1, E_k)$ = number of functions using both entities E_1 and E_k.
The Affinity Factor E_1 to E_k = $\dfrac{F(E_1, E_k)}{F(E_1)}$

The Entity Factor E1 to E_k is a percentage value that measures the degree of correlation or "similarity" between the two entity types with the aim of making a decision whether to cluster the entity pair together or not. It makes sense that commonly referred entity types by the same function(s) should be clustered together to form logical business areas. An Affinity Factor of 100% or approaching 100% would tend to cluster the entity types together, whereas Affinity Factors with low percentage values would separate the entity types into different clusters and business areas.

The algorithm incorporates in the Affinity Analysis engine will calculate the affinity factors of all entity pairs and generate a new Affinity Matrix that stores the affinity factors computed earlier. The next step in the Affinity Analysis is to perform the entity clustering. Entities with high affinity factors will be grouped together to form an entity cluster. This is accomplished by sorting those pairs of entities that have the highest affinity factor and conduct a test cycle to determine whether the pair can be grouped together to form a cluster.
For each cycle the algorithm will select the maximum remaining affinity between a pair of entities and checks whether either entity has been

assigned to existing group or cluster. If both entities were unassigned, then a new group or cluster will be created and both entities will be assigned to that group. On the other hand, if both entities have been assigned, then nothing happens. No new group created, neither assigned to existing group. However, if either one of the entities has already been assigned to an existing group, or the other entity has not been assigned, then the algorithm needs to determine whether the unassigned entity can be added to the existing group. This is done by calculating the "weighted affinity" based on the weighted average of the unassigned entity to the existing entities in the group or cluster. The following illustration describes the formula used to compute the weighted affinity of an entity E3 to a cluster consisting of two other entities, E1 and E2.

Say E1, E2 is assigned to Group 1, and to calculate the weighted affinity E3 say, to cluster E1, E2, i.e.

$$\frac{\begin{pmatrix}\text{affinity of} \\ \text{E3 to E1}\end{pmatrix} \times F(E1) + \begin{pmatrix}\text{affinity of} \\ \text{E3 to E2}\end{pmatrix} \times F(E2)}{F(E1) + F(E2)}$$

$$= \frac{\dfrac{F(E3,E1)}{P(E3)} \times F(E1) + \dfrac{F(E3,E2)}{P(E3)} \times F(E2)}{F(E1) + F(E2)}$$

is the value for the weighted affinity factor.

If the weighted affinity E3 to cluster E1, E2 is higher than any remaining affinity number, then E3 will be included in the cluster forming E1, E2, E3.

Results of the entity clustering are generated by the Affinity Analysis engine in the form of an Affinity Analysis Report. This report will be further analyzed by the user to examine the most appropriate label to represent the cluster of entities. A cluster or combination of clusters can form a potential business area that makes business sense to the enterprise. The prototype will prompt the user to enter the business area classifications representing the IS applications for each entity cluster generated by the engine. These IS applications will be used by the enterprise to justify its IT investment in acquiring the most appropriate IT solutions that meets its business strategy and requirements.

4.0 ANALYSIS OF CASE STUDY

In all two case study conducted (known as Company A, and B), the owner of the company themselves involve in testing the prototype.

The relationship between 8 business functions and 18 entities of company A produces 12 processes of CREATE (C) as shown in Figure 5. The calculation

of the affinity factors of all entity pairs generates the Affinity Matrix as shown in Figure 6. Affinity factor represent the strongest of relationship between two entities.

Figure 5: Matrix of business function/entity for company A

Figure 6: Matrix of computed affinity between entities for company A

The analysis of CRUD produces 4 cycles with 2 value of affinity factor which is 1.0 and 0.5. The affinity factor value of 1.0 is for bank (E1) with kendali pinjaman (E2) and lelong (E1) with kendali pinjaman (E2). The affinity factor value of 0.5 is for hartanah (E1) with mahkamah (E2) and lelong (E1) with mahkamah (E2) as shown in Figure 7.

Cycle #	Entity 1	Entity 2	Affinity Factor
1	BANK	KENDALI PINJAMAN	1.00
2	LELONG	KENDALI PINJAMAN	1.00
3	HARTANAH	MAHKAMAH	0.50
4	LELONG	MAHKAMAH	0.50

Figure 7: Report of affinity analysis for company A

The end result as shown in Figure 8 produces two business area classification which the user themselves put litigation system for entity group of bank, kendali pinjaman and lelong. While for the second area classification the user put in is convensing system for entity group hartanah and mahkamah. From this result, company A needs two type of information system which is one for litigation and second for convensing system as this two related work are the most work done in the company.

Group #	Business Area Classification	Entity Types in Group
1	LITIGATION SYSTEM	BANK, KENDALI PINJAMAN, LELONG
2	CONVENSING SYSTEM	HARTANAH, MAHKAMAH
	SAVE	

Figure 8: Resulting group for company A

In organization B, the relationship between 11 entities and 8 business functions produces 18 processes of CREATE (C) as shown in Figure 9. The affinity factor of all entity pairs is shown in Figure 10.

BUSINESS FUNCTIONS	Customer	Delivery Order	Invoice	Payment	Price	Purchase Order	Quotation	Sale	Spareparts	Staff	Supplier
Insurance	C										
Management				C						C	C
Promotion Section	C			C							
Purchase			C	C					C		
Sales Section	C		C	C			C	C			
Stock									C		
Technique Section										C	
Workshop	C							C			
Number Of Processes:	4	0	2	4	0	0	1	1	3	2	1

Figure 9: Matrix of business function/entity for company B

	Customer	Delivery Order	Invoice	Payment	Price	Purchase Order	Quotation	Sale	Spareparts	Staff	Supplier
Customer		0.00	0.25	0.50	0.00	0.00	0.25	0.25	0.25	0.00	0.00
Delivery Order	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Invoice	0.50	0.00		1.00	0.00	0.00	0.50	0.50	0.50	0.00	0.00
Payment	0.50	0.00	0.50		0.00	0.00	0.25	0.25	0.25	0.25	0.25
Price	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Purchase Order	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
Quotation	1.00	0.00	1.00	1.00	0.00	0.00		1.00	0.00	0.00	0.00
Sale	1.00	0.00	1.00	1.00	0.00	0.00	1.00		0.00	0.00	0.00
Spareparts	0.33	0.00	0.33	0.33	0.00	0.00	0.00	0.00		0.00	0.00
Staff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.50
Supplier	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	

Figure 10: Matrix of computed affinity between entities for company B

Twenty cycles are generated for E1 and E2 with affinity factor range of 1.0 and 0.5 as shown in Figure 11.

Cycle #	Entity 1	Entity 2	Affinity Factor
1	Customer	Quotation	1.00
2	Customer	Sale	1.00
3	Invoice	Quotation	1.00
4	Invoice	Sale	1.00
5	Payment	Invoice	1.00
6	Payment	Quotation	1.00
7	Payment	Sale	1.00
8	Payment	Supplier	1.00
9	Quotation	Sale	1.00
10	Sale	Quotation	1.00
11	Staff	Supplier	1.00
12	Customer	Invoice	0.50
13	Customer	Payment	0.50
14	Invoice	Payment	0.50
15	Payment	Customer	0.50
16	Payment	Staff	0.50
17	Quotation	Invoice	0.50
18	Sale	Invoice	0.50
19	Spareparts	Invoice	0.50
20	Supplier	Staff	0.50

Figure 11: Report of affinity analysis for company B

The end results as shown in Figure 12 are only 1 business area classification for group entity of customer, quotation, sale, invoice, payment, supplier, staff and spare part. The result of this is company B need one type of information system for it daily activities.

Group #	Business Area Classification	Entity Types in Group
1	Customer_Supplier_Staff System	Customer, Quotation, Sale, Invoice, Payment, Supplier, Staff, Spareparts
	SALE	

Figure 12: Resulting group for company B

From the two case studies, from the data analysis it is interesting for case study company B there is a clear different in it business area classification from the rest of the two. Company B only has one business area classification. This could be due to two factors. The first factor is that it happens because of the high level data entered and the second factor is because the number of business functions entered is relatively small.

5.0 CONCLUSION

The CATS is a web based application that has user friendly interface in helping end user without prior knowledge for ISP in mapping out their organization department, entities and business functions in a short period of time compare to the manual way. The system is a solution for small and medium firms in helping them to implement ISP. Even government agencies can use CATS to assist in their ISP projects as required by the Manpower and Modernization Planning Unit (MAMPU).

However, this tool has several limitations such as the interface for CRUD analysis in the system can be upgraded to reflect its user friendliness depending on the number of entities and business functions entered. User need to scroll up and down and left to right frequently if the amount of data is large. The output did not display organization lining as what is displayed on the computer screen.

6. 0 FUTURE WORKS

From the above mention limitations, there are number of aspects that future work can be done from this study as follows:

1. Researchers should continue with the prototype development until the full version that can generate an ISP for a company is completed.
2. The affinity algorithm and best guess is proven to be relevant in doing analysis for information retrieval process. Further research need to be done to test on how these two methods can be further applied to get better consistency in results.

7.0 ACKNOWLEDGEMENT

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