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1. Introduction

The day to day functioning of any organization involves many business processes. Each business process is comprised of different activities. The identification of activities and their cost drivers is a critical factor for successful Business Process Reengineering. Since the resources used by the activities form an integral part of the model, the identification of the cost drivers is also simplified.

This paper details the following :

1. It proposes the use of colored Petri nets for process modeling. Brimson(1991) identifies the process modeling approach to activity analysis as useful since it graphically links the inputs and outputs among activities and identifies the information flow in the processes. However, use of process flow charts, which is most commonly used in activity analysis cannot capture some of the aspects of office processes, like supervision, general management, etc. In addition, representing the complex business logic associated with activities would be difficult in such flow models. The use of colored Petri nets overcomes this limitation, as business logic and various office processes can be easily represented. In addition, the complexity of the system is handled by resorting to hierarchical representation of the processes.

2. The paper applies the concept of activity based costing to the management of the IS processes in firms. The cost structure of these processes, to our knowledge, has not been studied from the activity based costing perspective. The article proposes the use of activity based costing for IS processes. Such analysis could help the organization in making operational as well as strategic decisions as related to its IS processes.

2. Activity Based Costing (ABC)

In order to understand the cost structure underlying the business environment, managers need to focus on the activities that are involved in the production of the products or services. The identification of the activities and the costs and resources associated with it helps the manager accurately find the costs associated with a product or service. Accurate

product cost determination facilitates the managers to decide on the appropriate product mix, product price and market strategy.

2.1. Process-Product Perspective

In the design of an effective ABC system the identification of the hierarchical nature of the business processes is crucial [Ostrenga, 1990]. The business processes are comprised of a number of activities, which may not necessarily be sequential. The activities within a process are linked by the information flow inherent in the process. The processes are themselves linked to each other by the information flow between them. Depending on the information flow mechanism the precedence relationship between processes and activities are determined. For example, the acceptance of a sales order(activity) in the sales process (process) may initiate the process of material procurement (process), it may simultaneously trigger the design process. Thus the acceptance of the sales order (activity) precedes the process of material procurement and design.

The study of the business processes in a hierarchical manner facilitates a systematic identification and analysis of activities [Ostrenga, 90].

3. Petri Nets As Process Modeling Tools

Petri net theory evolved essentially to address the issues of design and uses of computer systems and systems in which information flow is given the prime importance. Petri nets are capable of representing causal dependencies of events, and concurrent and sequential processing of information. Depiction of the system at different levels of abstraction is possible. Well developed net theoretical methods can then be used to study the system parameters and behavior [Peterson, 1981]. Colored Petri Net(CPN) based modeling approach has been previously used in the modeling of computer systems and design and control of manufacturing systems [Bullers, (1990), Desrochers and Al-Jaar(1995)].

A Petri net models a system by explicitly defining the system states and actions. Typical examples of system states can be a call waiting, a job waiting for processing, a resource idling, etc. Typical actions in a system can be attending the call, beginning of processing of a job, resource being put into use to process a job, etc. The precedence relation between the system states and actions are represented by connecting the states and actions by a set of directed arcs. Thus each action will have a set of input states and a set of output states. The system states are represented by the presence of a *token(s)* in a set of *places* (which represent the state of the system). A change in the system state is achieved by the *firing* of a *transition* (which represents an action). A transition represents a business activity, and hence a set of transitions (a group of business activities) may represent a business process. The change is visualized by the movement of the *token(s)* from the input place(s) of the transition to the output place(s) of the transition.

4. CPN Modeling of IS Processes

The role of Information Systems has undergone a strategic shift from a predominantly supporting role to one of strategic importance [Porter and Millar 1985, Rockert and Scott Morton 1984]. However, the administration of the IS function within an organization has received the attention of the researchers only recently [Loh, 1993]. Very few articles have tried to analyze the cost structure of IS administration processes. Johnson (1991) proposed some cost and performance measures for the software development process. Abdel-Hamid (1988) has studied the economics of software quality assurance using simulation. However, both the works are more tuned towards software organizations and discuss the cost issues in isolation. In this article we apply the idea of activity based costing to the IS administration processes in any organization. Where, the understanding of such cost structures would lead to strategic decisions such as, outsourcing, downsizing, hiring strategy, etc.

In what follows, we describe a generic IS related process model using CP nets. The purpose of building such a model are two fold.

1) What are the cost drivers of the existing IS administration processes ?

2) How should the costs be allocated ?

Analysis of the above two questions would lead to the examination of the activity chain for value addition and possible modifications to existing processes for cost effectiveness.

4.1. IS administration Structure

The process modeling exploits the hierarchical modeling feature of CPN. At the top of this hierarchical model we represent the overall IS processes as in Figure 1.

We now describe the software development process in detail by the use of the CPN model shown in Figure 2. We have described four broad sub-processes in the software development process. Each of these sub-processes can be further sub-divided into several activities. For example, the develop application activity can be further sub divided into development of forms (user interface), maintenance programs, transaction programs, report programs, application maintenance programs, utility programs, unit test activities, module test activities, integration test activities, etc. Each of these activities could differ in the amount of time and resources required to finish. The advantage of building a hierarchical model is that the modeler can stop at any level of detail. The level of detail is dependent on the cost of data collection at the desired level and the benefits derived from that level. For reasons of brevity we have not provided the further decomposition of the activities here.

4.2. Cost Driver Identification

Once the model has been verified for accuracy we proceed to identify and measure the cost drivers and activity costs. With the graphical depiction of the system on hand, we would have identified the inputs to the activities and the outputs of the activities. Thus, a

qualitative analysis of the model (akin to visual inspection), we can associate the inputs and their costs to the activity.

For example, consider the design of interface, inputs and outputs activity from Figure 2. At the level represented in Figure 2, we note that there are two inputs to the activity, system interface and data needs. The time required (cost measure) for the design engineers to complete this activity would be dependent on the number of system interfaces and the data needs (measured in terms of the number of database files. Thus, the number of system interfaces and database files would determine the time required to finish this activity and thus can be considered as the cost drivers for this activity. A standard rate function would then be required to represent the relation between the time required and these cost drivers. We could then determine the activity cost by multiplying the time required by the hourly rates of the design engineers.

The activity costs could then be aggregated for the determination of process costs. While activity costs identification can lead to improvements in operational efficiency as a result of the identification of value added and non value added activities, process costs determination could form the focus for strategic decisions in the organization.

Use Of Simulation : One of the important advantages of using Petri net modeling is that the model can be simulated using many of the commercially available Petri net tools [Jensen,1992]. Simulation provides a cost-effective method of understanding the system behavior. Thus, when cost driver relation cannot be clearly determined from the graphical representation of the model, the simulation of the model with past data and the subsequent analysis of the activity costs would give valuable insights into what drives the activity costs. The use of simulation for cost driver identification and product cost allocation is an unexplored area in ABC literature and would form the basis for further research.

4.3. Cost drivers in software development

In order to make the discussion of the software development processes complete, some of the cost measures used currently by the industry are mentioned below. However, these measures would prove incomplete in the ABC scenario. The identification of the cost drivers for the IS activities would be based on the results of the use of Petri net modeling softwares and the results of the simulation results therefrom and is a topic of further research. The cost drivers currently used are given below.

Cost Drivers : Lines of Code, Function Points

Rates Used : Lines of Codes / Programmer Hour, Function Points / Programmer Hour Etc.

Lines of code is representative of the complexity of the application. However, advent of 4-GLs and code generators, the applicability of these measures loses significance.

A number of cost drivers need to be examined for their suitability for an ABC system in IS administration, they include, number of Database Files, Number of Screens in the application, number of Nodes in the Network, number of Programmers/Designers.

A number of these cost drivers could be extended to measure the performance of the IS administration processes and would thus indirectly result in the setting up of a streamlined responsibility accounting process in the organization and also in exploring opportunities for process improvements.

5. Summary

In this paper we have discussed a modeling method which uses colored Petri nets. The colored Petri nets allow analysts to examine and evaluate the system under study at various levels of details. In this paper we have discussed :

1. The use of colored Petri nets for activity analysis and identification. The hierarchical representation scheme of colored Petri nets is utilized to represent the system processes at different levels of abstraction. In addition, the business logic, time required for activity completion and the cost required of activity can be conveniently represented.

2. How activity based costing of IS administration processes could be carried out using colored Petri net models of the processes. We have also identified certain specific issues concerning cost drivers and activity costing as applied to IS administration processes.

References : Available upon Request