DEVELOPING AN ARCHITECTURE FOR THE PRODUCTION OF A GENERIC MODEL OF THE LOCAL MANUFACTURING INDUSTRIES

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ABSTRACT

The primary purpose of this study is to devise the architecture of a system that can develop a generic model of the restricted local small to medium sized manufacturing industries. With this architecture, a modeling tool or demonstrator system can be developed to capture the process flow of the manufacturing industries. This demonstrator system is composed of three major components which are in the form of a graphical user interface. These components are modeling tools, workplace and code generators. The modeling tools consist of a Domain Process (DP) structure, a Process (P) structure, an Activity (A) structure and a Relation structure which are used to represent different processes and relationships. This modeling tool is used to capture the process flow of a manufacturing industry. The workplace provides the area for the modeling structures to be constructed. This provides a structured view of the process flow of the manufacturing industry. The Code generator is the engine that is used to generate the coding templates from the model created on the workplace. With these coding templates, processes for the customization of the functions allow the software system to be developed according to the requirements of the modeler.

This research adopts a generic model from MIICI (Manufacturing Industry Information and Command Infrastructure). However, MIICI presents a generic model of a manufacturing industry in a mathematical form. Mathematical representations are not common to Malaysian manufacturing industries and they are also difficult to understand by the majority of people. Therefore, this research uses Domain Process, Process and Activity structures to produce the architecture of a system that can develop a generic model of the
restricted local small to medium sized manufacturing industries. From there, a software system can be constructed from the model of the application domain. Furthermore, the developed model can serve as a media of communication for individuals from same functions, fields and disciplines.
ABSTRAK


Kajian ini menggunakan model generik dari MIICI (Manufacturing Industry Information and Command Infrastructure). Walau bagaimanapun, MIICI mempersembahkan model generik industri perkilangan dalam bentuk matematik. Persembahan sedemikian tidak lazim di dalam industri perkilangan di Malaysia dan ia
juga agak sukar untuk difahami oleh kebanyakan orang. Oleh yang demikian, kajian ini menggunakan struktur proses domain, proses dan aktiviti untuk menghasilkan senibina sistem yang boleh membangunkan model generik sesuatu industri perkilangan bersaiz kecil ke sederhana tempatan yang telah ditetapkan. Kemudian sistem perisian akan dapat dibina daripada model yang diperolehi dari domain applikasi. Sebagai tambahan, model yang telah dibangunkan boleh berkhidmat sebagai media komunikasi untuk individu-individu daripada fungsii-fungsi, medan-medan dan disiplin-disiplin yang sama.
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1 INTRODUCTION

1.1 Overview

This research presents a modeling tool that can be used to support operations of small to medium sized manufacturing industries. According to Small and Medium Industries Development Corporation (SMiDEC), manufacturing companies or companies providing manufacturing related services with annual sales turnover not exceeding RM25 million or with full-time employees not exceeding 150 in number, are considered to be categorized as small to medium sized manufacturing industries.

In the manufacturing industry, there are many elements and operations that can be modeled to reflect different aspects of the enterprise. Therefore, manufacturing modeling is a process of building models of whole or parts of a manufacturing industry such as process modeling, resource modeling, data modeling and others. Modeling different aspects of a manufacturing industry is to prevent presenting an overly complex model that covers all the aspects of the industry. Every complex system is best approached through a small set of nearly independent views of a model; no single view is sufficient. This dissertation presents a modeling tool that can capture the process flow of an interested domain of the manufacturing industry. Captured processes can be customized to develop an application that can cater the need of the interested domain. It also describes the methodology developed for the use of the modeling tool in developing the model for certain domain of a manufacturing industry.
1.2 Background and Justification of the Research

In a growing country like Malaysia, industrial development plays a very important role in moving the economy of the country. Thus, manufacturing industries must be prepared to meet the dynamic, competitive and rapid changing market in order to survive.

The Manufacturing Industry Information and Command Infrastructure (MIICI) project was initially brought by the International Institute for Software Technology in United Nations University (UNU/IIST) with the intention to produce an industrial system capable of producing results without consuming excessive resources and also able to make quick decisions intelligently (Jan Goossenaerts & Dines Bjorner, 1994). MIICI project emphasizes mathematical models of products, enterprises and businesses environments as primarily tools for creating lean/agile supply-based industrial systems, which are environmentally sustainable by utilizing advanced computation and communication technology. From MIICI, this research is trying to adopt the concepts from the generic model in order to provide a structural view of local manufacturing industry process flows through the development of a framework for a generic model. A generic model in MIICI is created through defining terms, constructing terminologies and a mathematical framework to express the interflow models that matter for manufacturing and trade. By formalizing and systematizing the mathematical framework, a particular model can be constructed with the interflow of the phenomena processes of a manufacturing industry. However, advancement of the information and communication technology and manufacturing industries increasingly rely on using the information and communication technology in the daily operations of the manufacturing
industry; urging the use of rigorous techniques in software development for manufacturing operation with the context of market and industry today. This is applied in MIICI, where requirements and necessary information are expressed in a mathematical model and software development can be mechanically derived from the model. Therefore, adopting the MIICI concepts to local manufacturing industries is of importance because by developing framework for a generic model of local manufacturing processes, software system can be constructed from the model of the application domain. Software development processes through customization of the functionalities of the software system can develop an application that is required by the manufacturing industry.

As is already known, MIICI presents a generic model of a manufacturing industry in a mathematical form. Mathematical representations are not common and are difficult to understand for the majority of people. Different symbols are used to represent different sets of information. Training needs to be provided for those who are interested in following the methodology. However, source for skilled and trained instructors are not many since this representations are created by MIICI itself. Besides that, MIICI software development for a manufacturing industry should be understood within the general methodology in which software systems are constructed on the basis of the mathematical models of their application domain (Goossenaerts & Bjorner, 1994). Thereby, knowledge of mathematical representations and manipulation is essential.

Therefore, developing a manufacturing model which is simple, less time consuming and less training is required for local small to medium sized industries. This is because; there is a constraint on budgets allocation for most local small to medium sized
industries on the advancement of information and communication technology. Modeling can involve in different areas of a manufacturing industry like resource modeling which mainly deals with resources handling and data modeling; which involves data flowing and manipulation. However, representing different information on one single model would present an ambiguous environment for a viewer to understand. Focus on modeling process is required. Thereby, the process flow of the manufacturing industry is taken into consideration. This is because a process can involve a set of activities performed within a specific order of times with defined input and produce output (Davenport, 1993). Then the sequence flow from one process to another process can reflect the operations happening inside a manufacturing industry.

1.3 Research Objectives

In order to come out with a modeling tool that can facilitate the development of the model for the local small to medium sized manufacturing industries, there are two objectives that have to be achieved. There are:

- To come up with the architecture of a system that can develop a generic model of the restricted small to medium sized manufacturing industries.

- To develop a demonstrator system based on the framework for the layout of the process flow of the restricted small to medium sized manufacturing industries in order to simulate the actions carried out by the processes.

The primary objective of this research is to come up with the architecture of a system that can develop a model of the restricted manufacturing industry. Architecture of a system is just like a “blue print” or “navigator” that assists in designing a system. It
also can serve as a guideline for the user of the system which has been developed. Therefore, with the architecture of the system, a demonstrator system which is based on the architecture can be designed.

The secondary objective is to develop a demonstrator system or modeling tool system which is used to capture the process flow of a manufacturing industry. This demonstrator system is composed of several components. These components are modeling tools, a workplace and code generator. The modeling tools consist of several components which are used to represent different processes and relationships. The workplace is the area where the modeling tools are to be placed. The code generator is the engine that is used to generate the coding templates from the model created on the workplace.

This modeling tool system can be used to develop a model by capturing the process flow of the restricted manufacturing industries. From here, a software system can be developed to simulate the actions carried out by the processes through customization process.

1.4 Research Scope

This research would mainly focuses on how information technology can be applied to restricted small to medium sized local manufacturing industries. Major activities in a manufacturing industry, whether the size of it is small, medium or big, have to be performed on the shop floor. That means, the main concern in a manufacturing industry is related to the activities happening inside the plant. Therefore, there are different types of flows of data and activities happening around the manufacturing industry in
order to accomplish the task assigned to it. These flows can be categorized as process flows, resource flows, data flows and others. These flows can be known as manufacturing phenomena flows because these flows are the main events and incidents that make the manufacturing operations run.

Different sizes of manufacturing industries and business orientation can determine the complication of the manufacturing industry. For example, a manufacturing industry that manufactures cars would involve a lot of processes, data, resources, agents and other elements that are related to one another in order to produce the end product, the car. One process might distribute many different related processes, data, resources and other elements in order to accomplish the tasks of the process. Building a manufacturing model in one single model to represent all the different types of flows, objects, activities and others would be complicated and confusing. Therefore, there are multiple views like information model, activity model, process model and other models to represent different perspectives of a manufacturing industry.

This research is concerned on capturing processes involved in the local small to medium sized manufacturing industries. Therefore, special attention will be on processes in a manufacturing industry. From there, relationships are built between the logical view and the physical view so that customization on the logical part will impact on the real life through implementing some computing system.

1.5 Research Tasks and Dissertation Outline

In order to accomplish the research objectives stated at section 1.3, five specific tasks were undertaken. These five specific tasks were; literature review, development of
modeling structures, the technique used to create the modeling tool, and testing the modeling structures and modeling tool by creating an application through doing a case study at a local manufacturing industry and the development of a subsequent research plan. The following paragraphs will briefly outline the dissertation.

Chapter 1 presents the motivations and needs for the modeling tool to be developed. It also presents the scope of the modeling to process modeling in small to medium sized manufacturing industries. The ability to produce an application from the templates generated depends on the ability to model the processes. This chapter also discusses the objectives of the research and the tasks which were undertaken to realize these objectives.

Chapter 2 reviews some of the current literature relevant to this research. It discusses process modeling and reviews different modeling methods used in enterprise modeling. These modeling methods are IDEF0 Function Modeling, IDEF3 Process Description Capture Method, Object-Oriented Modeling, CIMOSA, and GERAM. Comparison of the modeling methods are made to find the difference among them.

In Chapter 3, the modeling scheme that is used in developing the modeling tool is presented. The focus of the modeling scheme is on the processes in a manufacturing industry. Thus, three different process structures are devised for capturing information from the processes in a manufacturing industry. These process structures are Domain Process (DP) structure, Process (P) structure and Activity (A) structure. Besides that, a Relation structure is also being used to establish the connectivity and relationship between processes in order to reflect the flow of the processes in a manufacturing industry.
Chapter 4 presents designs and techniques for creating modeling tools that can implement the modeling scheme that was discussed in Chapter 3.

Chapter 5 presents the results of the implementation of the modeling scheme, and briefly discusses the outlook of the application developed from using the modeling scheme.

Chapter 6 presents a trial of using the application developed from the modeling scheme. FFM Flour Mills (Sarawak) Sdn Bhd is selected as a resource of trial. The process flows from cleaning the raw materials to milling the raw materials into flour are discussed and the results are presented.

Chapter 7 presents the conclusion of the research. A brief summary of the work and significant accomplishments is provided. This chapter also provides recommendations for future research.