The Utilization of Information Systems for Supply Chain Management for Small and Medium Enterprises

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Abstract—**Small and Medium Enterprises (SMEs) have a significant role in developing economies such as in Indonesia, as they fulfill demands, provide jobs, generate tax, and ultimately provide economic resilience against recession. However, SMEs generally face challenges to survive, especially caused by the inefficiency of their business process. A solution to overcome this is by improving information visibility and coordination both internally inside the SMEs units, and among parties involved in their supply chains. This can be achieved through technology adoption, especially by implementing information systems for the SMEs. This paper describes a research roadmap and the associated ongoing work on Supply Chain Management Information System (SCM IS) for SMEs. As a case study, the SCM IS is designed and implemented on KUD Milk Agribusiness Dau; realizing manufacturing, marketing, and finance as the most salient parts of the SME's business process. The IS is developed on an open source ERP platform and enhanced with functionalities to leverage its strategic capability.**

Keywords-Small Medium Enterprises, Information Systems, Supply Chain Management

I. INTRODUCTION

Small and Medium Enterprises (SMEs) play a significant role in the economic growth of every countries including Indonesia. In this globalization era, SMEs are a dynamic private sector that provides meaningful jobs to reduce unemployment, fulfills customer demands, generates tax through domestic and foreign trade and leads Indonesia out of recession [1].

However, SMEs are facing some challenges to survive. One of the major challenges is inefficiency of SMEs in their manufacturing, distribution and marketing process. This leads to irresponsiveness to customers when the customers demand the products. According to [2], this inefficiency is as a result of lack information and coordination between business process and actors within a value chain.

With regard to the above shortcoming, several steps to support SMEs are required to be conducted. The steps are, for example, 1) to provide information for SMEs in supporting their daily business processes such as production plan and control information, market analysis, demand forecasting, and other information related to their relationship with suppliers, distributors and customers and 2) to help SMEs adopt and implement ICT for supporting their business process. In relation to this, Supply Chain Management (SCM) Information System is required [3].

This paper presents a research roadmap of Supply Chain Management Information System for Small and Medium Enterprise in Indonesia. Based on the roadmap, we also present our effort to help SMEs provide information in relation to manufacturing, marketing and financial process.

II. LITERATURE REVIEWS

A. Supply Chain Management System

According to [4], supply chain management is an integration of business processes started from suppliers to end-users to provide products, services and information as well as to provide added values for customers. Strategically, it has an important role for a company to: 1) reduce costs such as transportation costs and holding inventory costs [2], 2) provide required information for supporting daily business process between internal and external actors such as suppliers, distributors, customers and other partners within a value chain [5], 3) add values for customers as a result of delivering products and services on time and 4) increase Return on Investment (ROI).

With regard to its definition, SCM IS provides integration of business processes from suppliers to customers which are related to manufacturing information systems, marketing information systems and financial information systems. In this research, we customize Adempiere, an ERP open source software by adding new functionalities to support SCM IS.

B. ADempiere

ADempiere is an open-source ERP system that is designed to offers several convenient mechanisms for integrating several external services. It develops and supports an open source business solution such as Enterprise Resource Planning, Customer Relationship Management and Supply Chain Management. It also performs various administrative tasks such as opening and closing accounting periods, managing users, updating exchange rates and managing schedule reports.

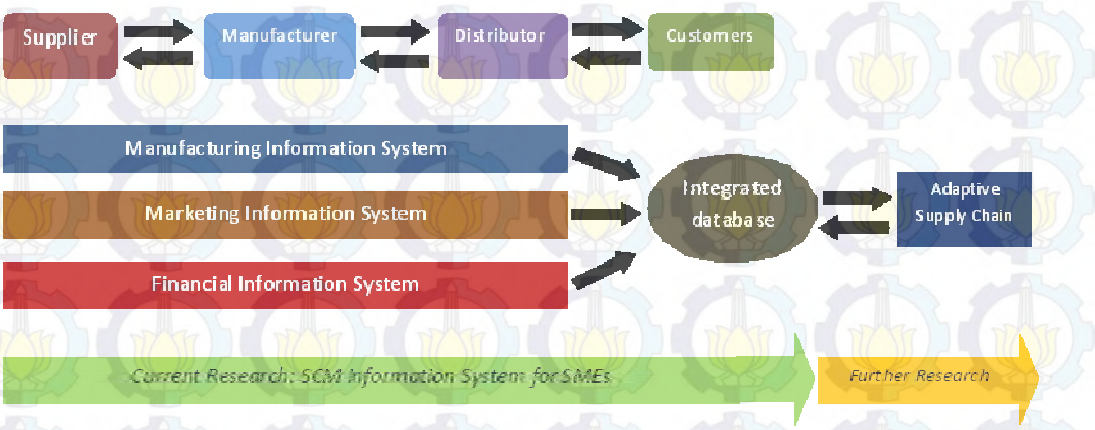

Figure II-1 Research Roadmap of Supply Chain Management for Small and Medium Enterprises

ADempiere can be used to automate all business processes such as financial, distribution, sales and service processes quickly, affordably and easily. It enables us to add new features and extend the existing features to suit our key business processes. Furthermore, we utilized ADempiere based on some considerations as follows:

- It has high performance, flexible, easy to use, facility of maintenance and scalability in the product application
- It uses technological jump from a client-server to a more modern, N-tier application
- It provides user Interface which is easy to use, intuitive, attractive and well organized
- It enables collaboration of a real community where it is possible to integrate everyone's contributions and catalyze further development
- It provides tools to test, upgrade, migrate and apply bug corrections or source improvements
- It enables us to improve the product, based on the global user community.

III. ROAD MAP

As a guideline for conducting our research, we develop a research roadmap called "An Adaptive Supply Chain Management for Small and Medium Enterprises" which aims to increase the profitability of SMEs through adaptive supply chain management. To achieve the aim, a database which integrates all actors within a value chain is required. The road map is depicted in Figure II-1.

According to the roadmap, there are three main components that must be integrated in order to improve the collaboration among all actors within a value chain. The three components are manufacturing information system, marketing information system and financial information system. We describe each of the components as follows.

a. Manufacturing Information Systems

Recently, SMEs encounter challenges to fulfill customers demand. One of the reasons is inability to predict future demand. This module is aimed to develop a demand forecasting application as a base to determine raw materials for production process. This modul consists of several sub modules that will be embedded to add the functionality of Adempiere. As a starting point, the sub modules being developed are production planning and controlling and demand forecasting.

b. Marketing Information Systems

One of the shortcomings in existing business process in traditional SMEs in Indonesia is the lack of utilization of information technology for documenting their marketing and sales activities. This is also the case in KUD Susu Dau Malang, where such activities are still manually recorded.

This practice is obviously inefficient. With manual documentation, recording marketing and sales activities is tedious and cumbersome. Furthermore, the data becomes hard to maintain and access, hindering further processing that is desirable, such as aggregating sales data to learn sales trends. Such manual practice also makes it difficult to apply the concept of Supply Chains, in which competitive advantage is gained through transparency between parties in a supply chain, promoting better cooperation between the parties involved.

Therefore, this research proposes the implementation of a Marketing Information System (MIS) for KUD Susu Dau Malang. The system is planned to have the functionalities shown in Figure III-1.

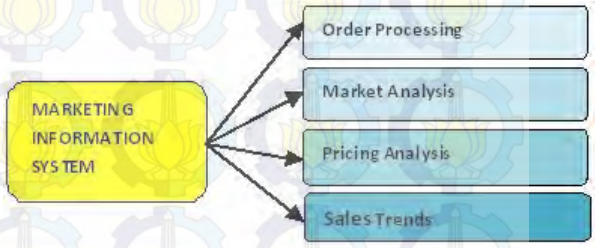

Figure III-2 Functionalities planned for the marketing information system of KUD Dau Malang

The most crucial component of the MIS is the electronic documentation of marketing and sales process. The above figure maps to the Order Processing module. Thus, the implementation of this module becomes the first priority in this research.

Three other functionalities of the MIS are analysis-related. With these modules, the data gathered through the Order Processing module are processed to provide insightful knowledge into market prospects, sales trends, and optimal price for optimal profit

c. Financial Information Systems

There are several sub modules being developed: accounting, costing, profit planning and portfolio analysis.

IV. METHODOLOGY

To develop a supply chain management information system, we need to explore the practice of business processes of Small and Medium Enterprises. Therefore, we rely on case study as our research strategy which is relevant to be used for explorative nature of research.

In relation to the case study, we decide to use a single case study as the starting point of our research. This decision is based on consideration that we need to fully comprehend the business process of SME in order to develop the three main modules. The selected case study is KUD Dau which its core business is to produce pasteurized milk.

To develop the SCM IS, each module has its own approach. Manufacturing IS utilizes ARIMA model for demand forecasting and EOQ to plan and control production. In marketing IS module, Monte Carlo simulation is used to predict total sales volume in attempt to gain more profit while financial IS focuses on creating a report for financial transactions occurred in SMEs.

V. RESEARCH PROGRESS

This chapter describes the research progress that we have done so far. The progress consists of three modules: manufacturing IS, marketing IS and financial IS.

a. Manufacturing Information Systems

The ultimate goal of this module is to predict raw materials used to produce pasteurized milk in KUD Dau. Prior activity to do this, we need to firstly develop a demand forecasting application to predict future demand on pasteurized milk. The flow of this module is depicted in the following figure.

Figure V-1 Flow of Manufacturing Information Systems

Demand Forecasting

Recently, this sub module is being developed by the students of Information System department under the bachelor thesis's title "Development of Demand Forecasting Module using ARIMA to Add the Functionality of Adempiere". In this module, we are developing a demand forecasting application to predict the future demand of KUD Dau. To facilitate the SMEs using the application, the demand forecast application will be embedded in Adempiere. The following figure depicts our approach to develop demand the forecasting application.

Figure V-2 Approach to develop demand forecasting application

The first approach is to develop demand forecasting model. There are several methods used to forecast demand such as Moving Average [..], ARIMA [..] of which each method has its own characteristics. However, considering the characteristics of data in KUD Dau, we use ARIMA as a model base of or demand forecasting. ARIMA or *Autoregressive* (AR) and *Moving Average* (MA) is one of quantitative forecasting method using time series approach. This method is applicable for stationer data. However, non stationer type of data is also applicable for this method as long as this data can be transformed into stationer data using differentiation and transformation technique.

To develop the forecasting model using ARIMA, several steps are taken: 1) determining data input which uses sales data of pasteurized milk for 140 ml and 200 ml from January 2006 up to December 2010, 2) identifying data pattern, 3) testing the parameter, 4) diagnostic checking and 5) verifying and validating the model. We rely on pasteurized milk data for 140 ml and 200 ml from January 2011 up to August 2011 for verifying and validating the model.

The second approach is to develop a demand forecast application. The application is then embedded in Adempiere to add the functionality of Adempiere.

Production Plan

This sub module is still being developed by Information System Department students under a bachelor thesis entitled "Implementation of EOQ Model with Quantity Discount to Optimize Inventory Costs in SMEs". This sub module is based on demand forecasting to determine order of supporting materials. There are 22 types of supporting materials that must be provided every day to make the production process of pasteurized milk. Those are cups, straws, plastics, dyes used to support the production process and others. In this research, EOQ model with quantity discounts is utilized to incorporate the variation in purchasing unit price.

Quantity Discount Model

A quantity discount is a reduced price (P) for an izztem when it is purchased in larger quantities. Furthermore, because of discounts is given for large purchases, as the quantity goes up, the holding cost increases. There is a tradeoff between reduced product price (P) and increased holding cost (H). To determine the minimum total cost, these following steps are required:

- *Step 1*: Assume that I is a percentage value. P represents the holding cost as a percentage of unit price (P). Instead of using a value of H (= h C), the holding cost is equal to IxP, so the Economic Order quantity can be determined as follows:

$$Q_{qd}{}^{*} = \sqrt{\frac{2\,D\,S}{I\,P}} \qquad (1)$$

where:

D = Annual demand of product
S = Fixed cost incurred per order
I = a Percentage value
P = Reduced product price
Q_{qd}* = Economic order quantity with quantity discounts

- *Step 2*: For any discount alternative, if the calculated optimum order quantity (Q*) is too low to qualify for the discount range, the order quantity can be adjusted upward to the lowest quantity that will qualify for the discount alternative.

- *Step 3*: Using the Total Cost (TC) equation below, compute a total cost for every order quantity (Q). Use the adjusted Q values. The total cost is related to an inventory model which is made to minimize the overall cost. The total inventory cost is the sum of material cost, order cost and holding cost as depicted in Eq. (2).

$$TC = CD + \frac{D}{Q}S + \frac{Q}{2}hC \qquad (2)$$

$$Q^{*} = \sqrt{\frac{2\,D\,S}{h\,C}} \qquad (3)$$

The optimal ordering frequency can be determined as follows:

$$n^{*} = \frac{D}{Q^{*}} = \sqrt{\frac{D\,h\,C}{2\,S}} \qquad (4)$$

where:
D = Annual demand of product
S = Fixed cost incurred per order
C = Cost per unit
h = Holding cost per year as a fraction of product cost
Q = Quantity to be order
Q*= Economic order quantity
n* = Optimal ordering frequency
TC = Total cost

- *Step 4*: Select the discount alternative which has the minimum Total Cost (TC) as depicted in Eq. 2.

Reorder Point

Reorder point represents quantity to which inventory is allowed to drop before replenishment order is made and can be determined as follows:

$$ROP = D \text{ X } LT \qquad (5)$$

where:

D = demand rate per period
LT = lead time in periods

The outputs of **EOQ** model with quantity discounts and reorder point will be uploaded to ADempiere as ERP software package released under an open source software license. In this case, a customizable inventory control module is required to fit the EQQ model with quantity discounts outputs through the addition of functions on the inventory control module.

b. Marketing Information Systems

Currently, the development of the modules for implementing the functionalities of the Marketing Information System is ongoing. The first stage of this work is through a research under the title of "The Development of Marketing Information System Enhanced with Monte Carlo Simulation for Optimizing Profit". We customize an open source Enterprise Resource Planning system, ADempiere, to the specific needs of KUD Milk Agribusiness Dau Malang. This platform is chosen because of its open source nature, eliminating the need to use expensive proprietary system. For order processing, we customize the Sales Order module of ADempiere.

The Monte Carlo simulation is for predicting sales volume, one of the key determinants in analyzing profits in KUD Milk Agribusiness Dau. As the commodity itself, fresh milk, has limited shelf-life, the appropriate profit-maximizing strategy is to exploit sales potential of each point-of-sales.

Figure V-3 The interconnection between total sales volume and sales volume at each point-of-sales

As shown in Figure V-4, the total sales volume is dependent on the sales at each point-of-sales. The total sales volume in turn determines the quantity of the product to be distributed at each location. In principle, sales at each point-of-sales has

a stochastic quality, in that the demand may increase or decrease without certainty. Therefore, the Monte Carlo simulation is very suitable for predicting total sales volume, since it is based on predicting an output, in this case the total sales volume, in the influence of uncertainty in its inputs, which in this case in the sales volume in each point-of-sales. In this research, the capability to predict sales volume is the heart of the market analysis functionality.

Pricing analysis is also largely dependent on sales volume. According to Van Westendorp method, there exist a price where revenue is maximized which occur at a certain sales volume. Therefore, the predicted total sales volume will be one of the factors in determining most-profitable price.

In this research, the Monte Carlo simulation module is to be developed on the platform of Java programming language. This would allow the Monte Carlo module to be integrated with the ADempiere sales order method, allowing direct processing of sales data from ADempiere, which is also Java-based. Thus, the analysis can be performed seamlessly.

c. Financial Information Systems

Recently, the development of this module is still ongoing under a bachelor thesis entitled "The Analysis of Financial Information System Using Profitability Ratio to Increase the Profitability of SMEs".

Accounting plays an important role in small business management to assist tracking in financial information for several business functions such as manufacturing and marketing activities. To convey this information, it is required to have accounting reports called financial statements. This report consists of balance sheet, income statement, statement of changes in equity, and cash flows.

Some of the steps required to prepare financial statements, such as creating: financial transactions; recording of all financial transactions based on the original evidence of transactions in one period; general journal related to the records of financial transactions; ledger; journal adjustment; financial statements (profit and loss analysis, balance sheet, and capital change); journal cover and after closing trial balance.

As with other parts of the SCM IS, the Financial Information System is also implemented by customizing modules of ADempiere, enabling company management to obtain the financial statements immediately to make a quick and right decisions which requires information on the financial condition of KUD Milk Agribusiness Dau Malang.

VI. CONCLUSION & FUTURE RESEARCH

This paper has described the roadmap to the SCM IS for SMEs, the design of the system and its components, as well as the progress of its implementation. At the moment the IS is still on its first stage of development, thus many aspects could very well be perfected on its future iterations. These adjustments would especially come from the problems which arise from its deployment at KUD Milk Agribusiness Dau. There are two aspects that may contribute to the improvement of the SCM IS. First is the customization of ADempiere modules to cater the need of the business process of KUD Milk Agribusiness Dau. It may be found that the current system is not entirely suitable for the business process, thus demanding further improvement. The second aspect is the implementation of modules with analytic functionality. Currently the methods being used, such as ARIMA and Monte Carlo, are chosen for relative ease of implementation. The capability of the modules is still quite limited, and so is the insight contributed to the making of strategic decisions. At the future, it is interesting to enhance these analytic modules both by improving the implementation and exploring the use of other methods of analysis.

In practice, the implementation of the SCM concept is very much influenced by the readiness of partners in the supply chain of a business. In the case of KUD Milk Agribusiness Dau, many partners still do not have the required infrastructure to implement the SCM concept, both from the internal management of their business process, and also the readiness to provide connectivity to relevant parties outside of their organizations. Thus, at this moment this research still puts heavy emphasis only on preparing KUD Milk Agribusiness Dau itself to be able to implement the SCM IS itself. This is done through the transformation of the manufacturing, marketing, and finance business processes, from being executed manually. In the future, to be able to fully reap the benefits of better business efficiency which comes from a seamless communication between partners in its supply chain, it is also necessary to consider the coordination between these partners, by helping and encouraging the implementation of SCM IS systems in their business processes.

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