DSG: A Decision Support System for Garment Industry

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ABSTRACT

The garment industry is one of the most important industries in Thailand. Unfortunately, most businesses in the industry are still lacking of information technology use in their production and management. This paper presents a design and implementation of a decision support system for garment industry called DSG. The DSG has potential to facilitate executive managers in their decision by providing goal seek and scenario analysis. This paper also discusses mathematical models used in the DSG to obtain the maximum profit for an organization. The results of model evaluation indicate that DSG can provide more than 87% accuracy when compared with real business data.

Keywords— Garment Industry, Decision Support System, Profit Prediction Model

1. INTRODUCTION

The garment industry is one of the most important industries in Thailand. The industry profit is worth more than six billion baht per year or five percents of the gross domestic product (GDP). The garment industry is also the most globalized industries in the world [1]. Hence, businesses in the garment industry are very competitive. One of the most popular concepts that can efficiently operate a garment business over competitors is to use the value chain concept [2]. The value chain is a business management concept that is based on a chain of primary and support activities, which add values to the product. Techniques and technologies, such as Decision Support System (DSS), can be used as a support activity for adding the values. However, the DSS must be customized for each business [3]. This paper proposes a design and implementation of the DSS for the garment industry.

From surveying related research in the garment industry, there are numbers of research in modeling and simulation for garment industry as follows. Brannon et.al [4] focused their research on agent-based simulation for decision-making process in supply chain and customer relationship management. Sepulveda and Akin [5] proposed an object-oriented simulation to model a cash flow of garment manufacturer. The model supports the decision in investment, production and financial plan. It is able to analyze average yearly profit, maximum loan per year, growth rate, etc. Dahllof [6] studied the life cycle assessment (LCA) of garment industry. The LCA was studied from defining goal and scope to process evaluation. The LCA was applied to garment industry in Sweden. Yeh and Yang [7] constructed cost models for garment dyeing based on postponement strategy. They used practical parameters to simulate various situations and found that the postponed cost model was well performed with large amount of data. Allgood and Manges [8] created a model for determining cost with respect to value and operation. The model balanced the R&D costs and maintained current operation to decide whether to continue development or suspend actions. Chen and Shih [9] suggested a model of using foreign-invests to gain direct access to overseas purchasing networks. It could boost the exporting of garment industry. Hughes [10] exposed the activity-based costing and activity-based management (ABC/ABM) to garment industry, especially SMEs in UK. He found that there were opportunities to improve the profitability of the SMEs by setting up ABC/ABM systems that enabled a business to focus on its activities and products. Joshi [11] studied situations in garment industry of South Asia in terms of competitiveness and productivity. His research found that most garment businesses were family business. They lacked professionalism in the industry. They were unwilling to invest information technology in the business. McCormick and Schmitz [12] wrote a manual for value chain research on home workers in the garment industry. It discussed several issues and methodologies regarding home workers in value chain of the garment industry.

Although there were numbers of research in modeling and simulation for garment industry as mentioned above, the decision support system that was specifically designed for the garment industry is still lacking. This paper presents a design and implementation of a decision support system for garment industry called DSG. The DSG has potential to facilitate executive managers in their decision by providing Goal Seek and Scenario ("What-If") analysis. It was implemented on top of prediction models discussed in this paper.

The structure of this paper is as follows. The next section introduces a DSG framework and profit prediction

models used in the DSG. Section 3 describes the methodology used to conduct the prediction analysis on the profit. Section 4 presents DSG implementation issues and techniques, while Section 5 discusses a DSG evaluation. The conclusions and future work are presented in Section 6.

2. DSG FRAMEWORK

A decision support system for garment industry (DSG) was designed for a garment organization under a hypothesis that the DSG can help managers decide on their organization management and investment. Different managers should access different decision information depended on their authorization. The framework of decision support system for garment industry is depicted in Figure 1.

This proposed system is an internet-based application consisting of three processes as follows: Authorization, Profit Prediction Model and Knowledge Inference Engine. Authorization is to control access to unauthorized data for different managers. It also provides different views for different authorized users. Profit prediction model is a process of estimating the organizational profit based on an income analyzer and a cost analyzer. While the income and cost analyzers are the estimators of income and cost, respectively. Knowledge inference engine applies all the estimated data to generate estimation plans for every department of the organization. More details of all processes are described in the section 2.1, 2.2 and 2.3.

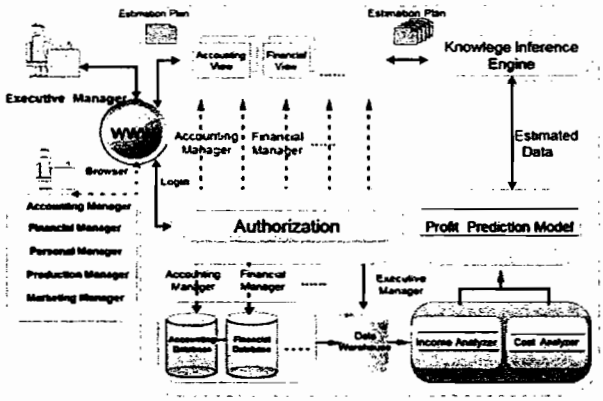

Figure 1. DSG Framework

2.1. Authorization

In general, a system has to be compiled with different views for different users or groups of users, e.g., an executive manager can access a data warehouse, including all the databases of the whole organization; while an accounting manager should be normally accessed the accounting database only. This concept is usually formalized as access control rules in any internet-based system. In the proposed system (DSG), the authorization is a process of specifying access rights to data. Data access is customized or authorized at the level of individual user. Users of this system are comprised of two groups of managers: department managers and executive managers. The department managers are responsible for maintaining and updating data stored in their department database. They are able to access analytical results of their department. These results will be used to support their decision such as worthy of adding an employee in their department. Executive managers can obtain summarized data of entire business to support their strategic decision.

2.2. Profit Prediction Model

The profit prediction model is a mathematic model, which is based on regression techniques using statistical data of the last configurable period. The data are kept in database and collected by department managers as mentioned in the previous section. These data include material cost, salary, utility cost, etc. The model can be operated in two modes: scenario and goal seek. The scenario is the mode where users specify factors (e.g., costs, numbers of employee, etc.) to forecast the maximum profit. If a factor is not given, the model will use a default value calculated by regression techniques. The goal seek is a mode where users specify expected profit. The model will calculate proper factors in order to obtain the expected profit. The expected profit (P) is calculated as

$$P = \left(\sum_{k=1}^{n} I_k\right) - \left(\sum_{k=1}^{n} C_k\right). \quad (1)$$

where I_k is used to predict income-related factors, e.g., sales and loans. The C_k is used to estimate cost-related factors, e.g., manufacturing costs, maintenance costs, salary, etc. The predicted factors are calculated by several regression techniques. For example, a linear regression technique is a basic regression defined as $Y = mX + b$, where m is a slope and b is a interception. They are calculated as

$$m = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - \sum x^2}. \quad (2)$$

$$b = \frac{\sum_{k=1}^{n}(x_k - \bar{x})(y_k - \bar{y})}{\sum_{k=1}^{n}(x_k - \bar{x})^2}. \quad (3)$$

All regression equations used in DSG are summarized in Table 1.

Table1. Regression Equations

Regression	Equation
Linear	$Y = mX + b$
Logarithmic	$Y = m(Ln(X)) + b$
Polynomial	$Y = c_1X + c_2X^2 + b$
Power	$Y = cX^b$
Exponential	$Y = ce^{bx}$
Multiple	$Y = b_0 + b_1X_1 + b_2X_2 + b_kX_k$

2.3. Knowledge Inference Engine

The knowledge inference engine is apart where it applied appropriate knowledge with the predicted data obtained from profit prediction model. Because using only the prediction models may not be accurate, the prediction results could be adjusted by knowledge of the experienced managers kept in a knowledge base. The knowledge, such as political and economic situations that have a direct effect to the material costs in the garment industry, could not be obtained from the statistical data.

Therefore, this knowledge inference engine could improve overall accuracy of the DSG. The results are represented as estimation plans for individual and group of department managers and executive managers, i.e., the DSG supports both individual and group decision support systems.

3. DSG IMPLEMENT ISSUES

The DSG is designed for department managers and executive managers of Thai garment industries that have both Thai people and alien workers. Thus, a user interface design of the DSG must support both Thai and English languages. The DSG can analyze and estimate cost, income and profit of the forthcoming months for each department and entire business. The DSG visualizes the prediction results with bar charts, pie charts, etc. They are implemented with PHP, AJAX, JavaScript, HTML and other related web technologies.

Figure 2 illustrates an example of graphic user interface (GUI) for department managers. The managers have right to access only their department data. They can add, edit, update or delete parameters of each factor. The interface is designed as either drop-down lists or text-boxes with error checkers as counter measures for mistake data input. The stored data will be used later in the analysis step.

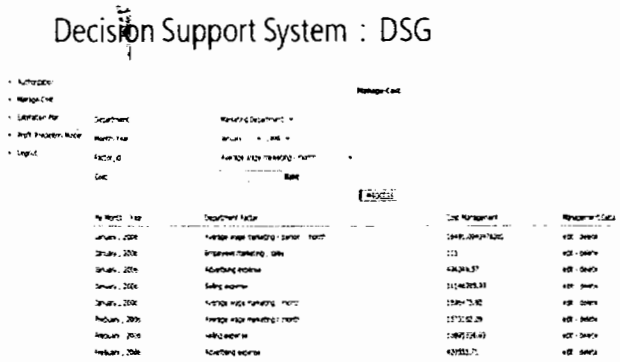

Figure 2. GUI of Department Managers

The executive managers can access data of entire business. They can also override data of all departments filled by department managers. The DSG provides executive summary reports with real and predicted data to executive managers. The managers can adjust each factor to predict profit (i.e., scenario or what-if analysis). They can also specify the profit. The DSG computes appropriate factors for given profit (i.e., goal-seek analysis). Examples of the executive summary reports are shown in Figure 3, Figure 4, Figure 5 and Figure 6.

Figure 3 presents a view of cost and income of a month specified by user. If the specific time is in the past, it will display the actual data as recorded. However, if the specific time is in the future, it will display estimated data obtained from one of the prediction methods as defined in Table1.

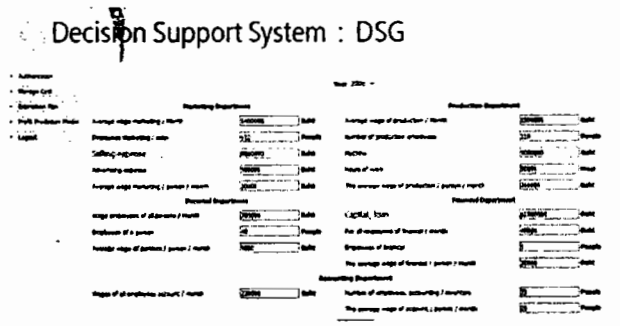

Figure 3. Estimated Data of Cost and Income

Figure 4 is an example of a bar graph that shows a trend of total income, where the solid bar is the actual data of the last twelve months and the bar with strip lines represents a predicted income of the next month.

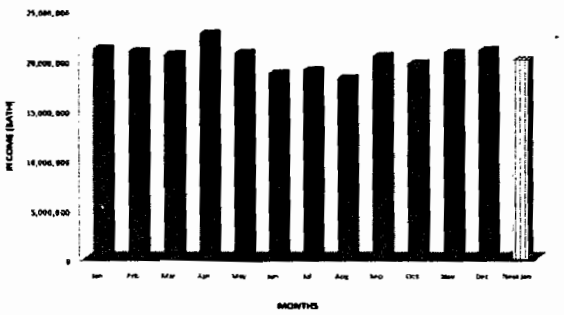

Figure 4. Trend of Incomes and an Estimated Income

To make the view of estimated costs clearer to the executive officers, the DSG can display the estimated cost percentages of individual department with a pie graph. The pie graph is shown in Figure 5.

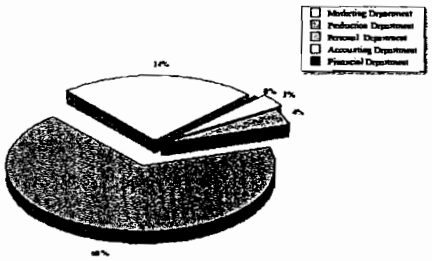

Figure 5. Estimated Cost Percentages of Each Department

Figure 6 presents a bar graph that represents a profit of each month. The height of each bar is the income of each the month. The lower area of each bar is the cost and the top area is the profit (i.e., profit = income – cost). The right-most bar is the estimated profit of the next month compared with the actual data of the last twelve months. All of the estimated values are obtained from the best regression technique (as shown in Table 1) by computing with the actual data of the last three years.

4. DSG EVALUATION

This DSG evaluation has been conducted with data obtained from an enterprise resource planning (ERP) of a 400-employee garment business in Thailand. The data is collected between year-2006 and year-2008. After the DSG is installed, it will perform several tests to select the best model for each factor and fine-tune an appropriate parameter for the estimation. Table 2 presents an example of the evaluation results. It indicates that in the worst case, the DSG can perform more than 87% accuracy (less than 13% of errors). The accuracy of the model is depended on fluctuation of the data, e.g., if data is the same in every month (such as a cost of machine maintenance), every model can perform very well. On the other hand, if the data is very fluctuating, the accurate prediction might be very difficult to obtain when performed by any model.

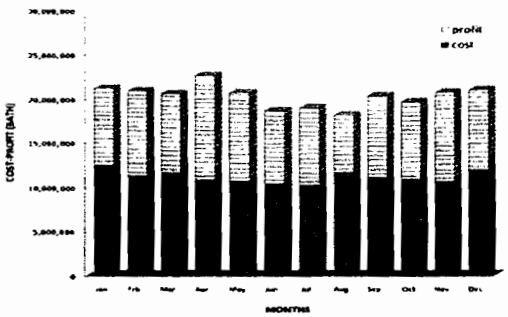

Figure 6. Computing an Estimated Profit

5. CONCLUSIONS AND FUTURE WORK

This paper presents a design and implementation of a decision support system for garment industries called DSG. The DSG has potential to facilitate department managers and executive managers in their decision by providing Goal-seek and Scenario ("what-if") analysis. It supports both individual and group decision support systems. The paper discusses profit prediction models based on several regression techniques used in the DSG to obtain the maximum profit for an organization. The model evaluation results indicated that DSG could provide more than 87% accuracy when compared with real business data. Some improvements could be implemented in near future. The profit prediction model used in DSG can be extended with alternatively forecasting methodologies such as neural networks. The DSG should be deployed in garment industries and performs usability and reliability testing.

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Table 2. Evaluation Results of the DSG

	(%) Error						
Factors	**Linear**	**Logarithm**	**Polynomial**	**Power**	**Exponential**	**Multiple**	**Best**
Marketing Department							
Overall cost	22.33	3.45	3.57	5.19	3.38	N/A	Exponential
Advertising expense	4.08	5.15	2.01	5.96	4.99	N/A	Polynomial
Total income	9.31	11.69	9.30	11.50	24.49	N/A	Polynomial
Average wage/month	17.40	12.31	17.40	9.16	14.42	N/A	Power
Average error	*8.66*	*14.95*	*8.16*	*7.45*	*11.25*	*15.20*	*Power*
Production Department							
Overall cost	12.59	0.80	0.81	0.05	0.61	N/A	Power
Machine expense	0	0	0	0	0	N/A	All
Average wage/month	29.76	12.37	29.76	27.58	26.91	N/A	Logarithm
Average error	*11.10*	*13*	*24.9*	*14.38*	*10.26*	*21.42*	*Exponential*
Personal Department							
All employee wages/month	0.69	11.30	10.02	14.34	1.59	N/A	Linear
Average error	*2.68*	*6.98*	*3.85*	*7.93*	*2.94*	*29.19*	*Linear*
Accounting Department							
All employee wages/month	4.31	4.36	4.01	4.92	4.69	N/A	Polynomial
Average error	*3.62*	*6.47*	*5.93*	*7*	*3.77*	*5.52*	*Linear*
Financial Department							
Overall cost	0.00	0.00	0.00	0.00	0.00	N/A	All
Fund (including loan)	0.00	0.00	0.00	0.00	0.10	N/A	All
All employee wages/month	0.00	0.00	0.00	0.00	0.00	N/A	All
Average error	*0*	*0*	*0*	*0*	*0.1*	*18*	*Linear*

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