A Cloud-Based Enterprise Application for Coating and Plating Industrial Technology Incorporated with Product Inventory Management and Analysis

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Abstract - The advent of cloud-based technologies provides different enterprises with enhanced business flexibility at reduced cost. This paper presents a cloud-based application for real-time products monitoring and inventory analysis for metal plating and coating industry. The system helps the administrator and project manager on data analysis of products and inventory records to develop a strong marketing strategy and decision making. Thus, this work is essential for the evolution of metal plating and coating techniques, production planning, monitoring, and continuous improvement of the operation of metal plating and coating industry. Prior to the implementation of the system, interviews from key persons in the industry was conducted to clarify some procedures, or documents needed for the project. The system was evaluated utilizing ISO 9126 of software evaluation criterion namely: Functionality, Reliability, Usability, Efficiently, Maintainability and Portability. In general, the results showed that the system has adhered the international standards for software.

Keywords - Cloud-based application; Linear Regression; Forecasting; Data Analysis; Product Inventory Management

I. INTRODUCTION

Product monitoring of metal plating and coating manufacturing takes up a huge amount of time and effort for the management and staff. With this kind of services plating and fabrication as well as monitoring of product is difficult. Moreover, estimating the chemicals needed for plating is a very challenging task. Plating section and fabrication services have been inefficient to manage especially when the product management and inventory analysis is needed for decision-making. [1]

This paper presents the design, development and implementation of a cloud-based application for real-time products monitoring and inventory analysis for metal plating and coating industry. The cloud-based based application enables the enterprise business flexibility at reduced cost. [2] Cloud-based application is utilized to deal with the business process of Coating and Plating Industrial Incorporated. The system gives a virtualized resource to access over the web, and transform the manual industrial business, to distributed computing platform to align product innovation with business strategy and create intelligent factory networks that encourage empower successful cooperation [3]

Prior to the implementation of the system, interviews from key persons in the industry was conducted to clarify some procedures, or documents needed for the project. Furthermore, historical data from the company relevant to the system is also used as an input to the process. The system was evaluated utilizing ISO 9126 of software evaluation criterion namely: Functionality, Reliability, Usability, Efficiently, Maintainability and Portability.

The paper is organized as follows. Section 2 introduces those related technologies that is used for system development. In Section 3 describes how the system was developed. Section 4 shows the output of the system. System evaluation is discussed in Section 5. Conclusion is provided in Section 6.

II. RELATED TECHNOLOGY

A. Cloud Technology

Cloud-based technology is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [4]. Using of cloud computing services in business can make a big cost advantage, which includes investment and operating costs saving, high elasticity of services as well as increased flexibility of certain business processes. [5]

By using distributed computing, companies can control their framework limit more precisely. In periods where request is high, companies require enough limit in order to be able to face this expanding request. Therefore, utilizing basic on-premises frameworks, they should possess the fundamental database for the entire year with a specific end goal to react to the extreme request only for a brief period. Be that as it may, with the advent of cloud innovation, organizations where given the chance to adjust their ability consequently as per their needs and scale their computing power depending on demand. [6]
According to [7], the significance of cloud technology in the enterprise has two points of view (1) Enterprises consumer applications provided in the public cloud. This might be an application designed to process employee payroll data, or it might be a customer relationship management system. (2) Enterprises utilize cloud-based hosting solutions to deliver applications to users. By doing so, companies are freed from the maintenance and upkeep of production systems since the cloud provider is responsible for providing infrastructure resources to meet the demands users place on the application.

B. Forecasting using Linear Regression

Forecasting methods is calculating the future demand to provide accurate forecast for the wireless companies. [8] Accurate demand forecasting is crucial to inventory planning and control because estimating the lead time demand helps set an appropriate level of stock anticipation [9]. It is an important role in company as an input for operation of planning Poor forecasting effects are stock outs or high inventory, low service level, rush orders, inefficient resource utilization and bullwhip propagating through the upstream supply chain [10].

The forecasting of stock price movement in general is considered to be a thought-provoking and essential task for financial time series' exploration. A study of Least Absolute Shrinkage and Selection Operator (LASSO) method was based on a linear regression model as a novel method to predict financial market behavior. LASSO method is able to produce sparse solutions and performs very well when the numbers of features are less as compared to the number of observations [11].

The linear regression techniques determine the chemical stocks and level of the inventory to estimate the total cost at the given level of activity based on past cost data, that may be used to analyze trends of chemicals consumption for a certain period of time. [12] Linear regression is mainly the essential type of regression and frequently used in predictive analysis. Uses of regression analysis are (1) causal analysis, (2) forecasting an effect, and (3) trend forecasting. A regression technique to determined optimum inventory levels to maintain accurate raw materials to achieve satisfying requirements level the following are; firstly, the regression might be used to identify the asset of the effect that the independent variable(s) have on a dependent variable. Secondly, it can be used to forecast effects or impact of changes. That is, the regression analysis helps the company to understand how much the dependent variable change with a change in one or more independent variables. Thirdly, regression analysis predicts trends and future values [13].

A functional linear models are regression models based on curves instead of single values. It allows to consider the whole process instead of a limited number of time points or features. These models analyze the flow volume and the whole streamflow curve during a given period by using precipitations curves. The functional model is shown to lead to encouraging results. It detects special features that would have been hard to see otherwise is pointed out. Also, it compares to the artificial neural network approach and the advantages and disadvantages of both models are discussed [14].

III. SYSTEM DEVELOPMENT

A. System Architecture

Figure 1 illustrates the system architecture for cloud-based enterprises application. Cloud is a terminal emulator to be distributed to the company server so that the records saved in the cloud database can be retrieved using the web browser. The software entails a combination of relevant programming languages, database systems servers, and third-party tools needed at the stage of system architecture. In the next section we outline the software and hardware used for the development of the system.

![Figure 1. System Architecture](image)

B. Software and Hardware Requirements

Tables I and II show the software and hardware requirements used in full development of the system.

<table>
<thead>
<tr>
<th>Requirements/Items</th>
<th>Version</th>
<th>License</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xampp Server</td>
<td>5.6.24</td>
<td>open source</td>
</tr>
<tr>
<td>MySQL</td>
<td>2.5</td>
<td>open source</td>
</tr>
<tr>
<td>Sublime Text Build</td>
<td>3.1.26</td>
<td>open source</td>
</tr>
<tr>
<td>Photoshop</td>
<td>C26</td>
<td>Portable</td>
</tr>
</tbody>
</table>
C. Data Requirements

C1. Historical Data: Historical data from Coating and Plating Industrial Technology incorporated was collected, which included the documentation of past inventory stock of the company as well as the raw materials that the company used to produce the items it sells. Due to confidentiality and privacy issue these data cannot be disclosed in this paper. These data are used as an input for the predictive analysis in this project.

C2. Interview: A preliminary interview was conducted to understand the company problems, issues, and challenges faced by the company in the current fabrication services. This involved Finance Manager, Head Supervisor, Warehouse Clerk, Management Information System / Accounting, Production Operator. The results of the interview were used to understand the entire procedures or processes involved, and utilized during the design, development, and evaluation of the systems project.

D. Context Flow of the System:

Figure 2 shows the context flow of the system. The administrator will be the one to manage all business transaction of the company and monitor the operation of the system. Administrator also adds user account, view product report, generate inventory report and manage databases of the system. The receiving department is responsible for adding new product, new customer and record the incoming products to be platted, it will be sent to the system and will be saved to the cloud. The production head they are responsible for transferring of the product to the different section where the platting will be done and will be sent and save to the system to monitor the location of the product. Quality Control will be assigned to check the quality of the finished product they will be notified for the product to be checked using the system and then verify if the product is good for delivery. MIS are the one who is assigned to create the delivery receipt and product for delivery.

![Figure 2. Context flow of cloud-based application](image-url)
IV. SYSTEM OUTPUT

A. Product Inventory Management

To monitor the product inventory, the system provided a module for product delivery. Here, adding of product to the inventory is done. Next, the module for use product to items is the part where products are used for plating after which the system will update the status of the product adding the delivery and subtracting the product used for plating. Finally, the system will then produce the report (see Figure 3).

Figure 3. Product inventory process flow

Figure 4 shows the incoming item registration page of the system which contain the client name, item description, Part no., Item count, Purchase order no., References no., Department, Process type and Remarks of the inventory management. In this page, the production head supervisor is the one who manage this account and distributed the items to be platted to the different section in process type. With this information, the system will be able to add the product to be process.

Figure 4. Incoming item registration page

Figure 5 depicts the inventory stocks page of the system which contain the stock list client name, item description, item volumes, item unit of measurements, expiration date, and action the inventory management. In this module, the warehouse supervisor monitors the status of the stock of the raw material needed. When raw materials are already below the average stocks or in critical point the system will inform the user that there are raw materials which are in critical point. Expiration date of chemicals can be filtered using date picker and shows the expiration date of a single chemical.

Figure 5. Inventory stock page

As shown in Figure 6 the item monitoring page includes: client name, reference no., item, process, last updated and view the system database. Through this page, monitoring of items that is being process is easy to locate. In addition, items were first identified to locate the exact process. Moreover, the date of the transfer of the items is easily identified. Production supervisor is the one whose manage this account and can add, update, search and view the history of the items.

Figure 6. Item monitoring page

To view the availability of the product, an inventory report page is shown in Figure 7. Through this report, out of stock cases of a product is avoided.

Figure 7. Inventory report page.
The system also features a page where you can view the current trending process (see Figure 8). This includes process type, process percentage and process on demand in a specific month. This page is particularly helpful for users in identifying process that should be prepared in advance for forecasting techniques. The system also provides data filtering in viewing top process demand using bar graph form. The process demand is frequently consumed, while the lower bar means the process is seldom consumed.

![Figure 8. Tending process](image)

The system also uses linear regression analysis to determine the chemicals stocks and level of the inventory to estimate the total cost at the given level of activity based on past cost data. In this module the administrator and warehouse supervisor can view and monitor the chemicals stocks of the inventory management. By employing linear regression as a statistical technique, the system can analyze trends of chemicals consumption for a certain period. Analytical report is used in finished item by identifying which chemicals is mostly consumed in a certain month represented by line graph. The higher the line means the product is frequently consumed. On the other hand, the lower line means the product is seldom consumed (see Figure 9).

![Figure 9. Sample linear regression analysis](image)

V. SYSTEM EVALUATION

The system was evaluated utilizing ISO 9126 of software evaluation criterion namely: Functionality, Reliability, Usability, Efficiently, Maintainability and Portability. Description of each criterion is depicted in Figure 10. Evaluation was accomplished by thirty (30) selected respondents composed of production staff, quality control personnel, warehouse supervisor and MIS Administrator. Table 3 shows the overall evaluation result of the system.

Portability obtained the highest means core which is 4.52 with verbal interpretation of Strongly Agree. This means that respondents strongly agreed that the system to be easy to maintain and modifications and it is easy to be transferred from one environment to another without errors.

On the other hand, the four (4) main characteristics namely: functionality, reliability, usability and efficiency obtained a verbal interpretation of MODERATE AGREE with having a weighted mean of 4.28, 4.12, 4.47 and 4.20 respectively. This means that the respondents moderately agreed that the system has good functionality, reliability, usability and efficiency.
In general, the software obtained an overall mean of 4.35 with verbal interpretation of MODERATE AGREE. This means that the respondents moderately agreed that the system has been able to meet the International standards for software in conformity with ISO 9126.

TABLE III. OVERALL EVALUATION RESULT

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Overall Mean</th>
<th>Descriptive Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionality</td>
<td>4.28</td>
<td>Moderate Agree</td>
</tr>
<tr>
<td>Reliability</td>
<td>4.12</td>
<td>Moderate Agree</td>
</tr>
<tr>
<td>Usability</td>
<td>4.47</td>
<td>Moderate Agree</td>
</tr>
<tr>
<td>Efficiency</td>
<td>4.20</td>
<td>Moderate Agree</td>
</tr>
<tr>
<td>Maintainability</td>
<td>4.52</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Portability</td>
<td>4.52</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Overall Mean</td>
<td>4.35</td>
<td>Moderate Agree</td>
</tr>
</tbody>
</table>

VI. CONCLUSION

This paper presented a cloud-based enterprises application for Coating and Plating Industrial Technology incorporated with product management and inventory analysis. The developed system meets all the needed requirements of the client. This includes identification of which raw materials that are below standard stock or raw materials that need to control. The system also provides forecast which chemicals is mostly used or processed. The system can also show the expiration dates of chemicals, if there is a multiple expiration date of single raw materials. In addition, the system provides reports such a process report, raw materials report, and finished items reports. The system also used linear regression analysis to determine the chemicals stocks and level of the inventory to estimate the total cost at the given level of activity based on past cost data. In general, the software obtained an overall mean of 4.35 with verbal interpretation of Moderate Agree. This means that the respondents moderately agreed that the system has been able to meet the International standards for software in conformity with ISO 9126 and it can perform all the functions based on its stated objectives.

REFERENCES