

## AN ALTERNATIVE MODEL FOR ERP MAINTENANCE STRATEGY

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### Abstract

*For the past few years, it has been possible to buy a business application including transaction processing systems for such tasks as accounting, manufacturing, or human resources as a packaged product. Packages to do this collection of work are generally referred to as Enterprise Resource Planning (ERP) systems. Most ERP systems are huge because of the diversity of tasks they must perform. The ERP systems are providing an integration of several tasks, and the flexibility to perform those tasks at enterprises with vastly varying needs. But, only few of these ERP systems developed have actually considered maintenance strategies. Maintenance is a complex process that is triggered by planned periodic repair (scheduled or planned maintenance), equipment breakdown or deterioration indicated by a monitored parameter (unplanned or emergency maintenance). This process includes planning, scheduling, monitoring, quality assurance and the development of necessary resources such as workshop, labor, machines, equipment, tools, spare parts and materials.*

### 1. Introduction

An enterprise resource planning (ERP) system is a software architecture that facilitates the flow of information among the different functions within an enterprise. Similarly, ERP facilitates information sharing across organizational units and geographical locations. ERP system provides consistency and Visibility or transparency across the entire enterprise.

This system was introduced into companies to solve various organizational problems and to provide an integrated infrastructure. ERP solutions are designed to solve the fragmentation of information in large business organizations, and integrate all the information flowing within a company [1].

A primary benefit of using ERP is easier access to reliable, integrated information. A related benefit is the elimination of redundant data and the rationalization of processes, which result in substantial cost savings. [2]. Beside of primary benefit which mentioned above, ERP also has several benefits including:

- Improved work process.
- Increase access to available data for decision making.
- Timely and accurate information.
- Increased Customer Response Time.
- Quick response to changing business operations and market conditions, resulting in improved competitive advantages.
- Reduced paper
- Single address book (Customers, vendors and employee).

However, research about fundamental issues of ERP maintenance and upgrade is at an early stage if we compare with research about ERP implementation issues over the past two decades. Maintenance has been considered as a support function, non productive and not a core function adding little value to business. However, it has been noticed that many manufacturing industries have used various approaches to improve maintenance effectiveness [5]. Many companies have recognized that maintenance of assets have a critical part of the operational function. An effective maintenance strategy can significantly contribute through adding value to the production activities.

Recent maintenance strategies employ many techniques such as corrective maintenance [1], fixed-time maintenance, condition-based maintenance, improvement maintenance and selective maintenance.

This paper is divided into five sections. Section 2 gives an overview of Enterprise Resource Planning (ERP) including new framework that proposed in previous researches, evolutionary of ERP and ERP market. In Section 3, we present about Maintenance Management as a crucial function in implementing

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ERP while Section 4 present about related works that dealing with this paper. Section 5 presents a proposed alternative framework of maintenance management system. Section 6 concludes the paper.

## 2. Enterprise Resource Planning (ERP): An Overview

ERP allows companies to integrate various departmental information. This system has evolved from a human resource management application to a tool that extend to IT management. For many users, an ERP is a complete System that performs everything from entry of sales order to customer service. The ERP attempts to integrate the suppliers and customers with the manufacturing environment of the organization. For example, a purchase entered in the order module and passes the order to a manufacturing function, which sends a materials request to the supply-chain module, which gets the necessary parts from suppliers and uses a logistics module to get them to the factory. At the same time the purchase transaction shows in general ledger module as an output. ERP stops treating these transactions separately as stand alone activities and considers them to be a part of interlinked processes that make up the business [3].

An overview of ERP systems including some of the most popular functions within each module is shown in Figure 1. However, the names and numbers of modules

in an ERP system provided by various software vendors may differ. A typical system integrates all these functions by allowing its modules to share and transfer information by freely centralizing information in a single database accessible by all modules [4].

The various modules of ERP include engineering data control (bill of materials, process plan and work center data), sales, purchase and inventory (sales and distribution, inventory and purchase); material requirement planning (MRP), resource flow management (production scheduling, finance and human resources management), works documentation (work order, shop order release, material issue release and route cards for parts and assemblies), shopfloor control and management and others like costing, maintenance management, logistics management and MIS. Also, the model of ERP includes areas such as finance (financial accounting, treasury management, enterprise control and asset management), logistics (production planning, materials management, plant maintenance, quality management, project systems, sales and distribution), human resources (personnel management, training and development and skills inventory) and workflow (integrates the entire enterprise with flexible assignment of tasks and responsibilities to locations, positions, jobs, groups or individuals) [6].

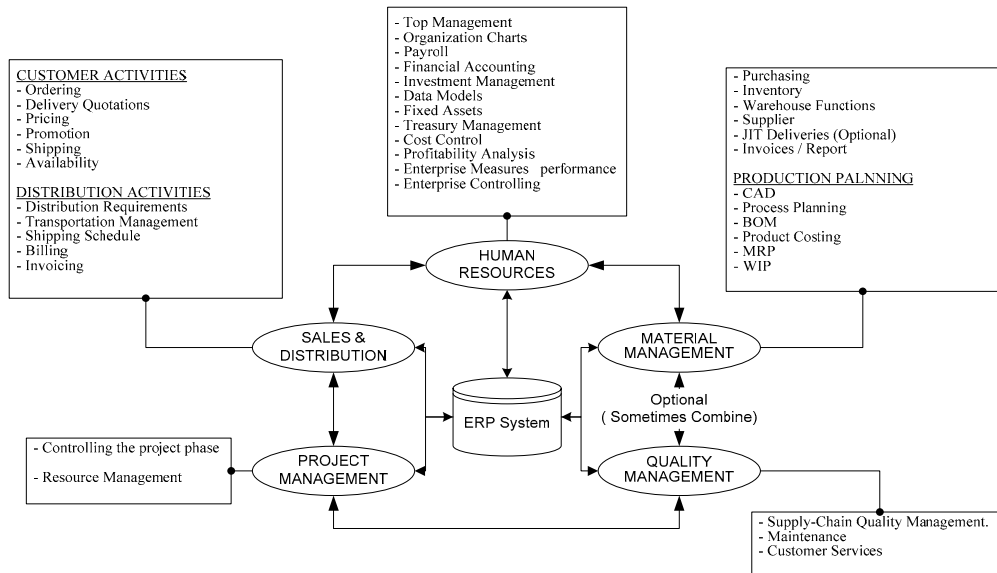


Figure 1: ERP System modules.

## 2.1. The evolution of ERP

The focus of manufacturing systems in the 1960's was on Inventory control. Most of the software packages (usually customized) were designed to handle inventory based on traditional inventory concepts. In the 1970's the focus shifted to MRP (Material Requirement Planning) systems that translated the Master Schedule built for the end items into time-phased net requirements for the sub-assemblies, components and raw materials planning and procurement.

In the 1980's the concept of MRP-II (Manufacturing Resources Planning) evolved which was an extension of MRP to shop floor and Distribution management activities. In the early 1990's, MRP-II was extended to cover areas like Engineering, Finance, Human Resources, Projects Management etc

i.e. the complete of whole activities within any business enterprises. These MRP II extensions named ERP (Enterprise Resource Planning). During the 1990s ERP vendors added more modules and functions as “add-ons” to the core modules giving birth to the “extended ERPs.” These ERP extensions include advanced planning and scheduling (APS), e-business solutions such as customer relationship management (CRM) and supply chain management (SCM) [14] and more concerning to web services. Nevertheless, extended ERP almost exactly to Open Source ERP nowadays, which is it offer more strengths rather than weaknesses such as Compiere, Open Bravo and TinyERP. At Figure 2, it can be seen a historical events related with ERP.

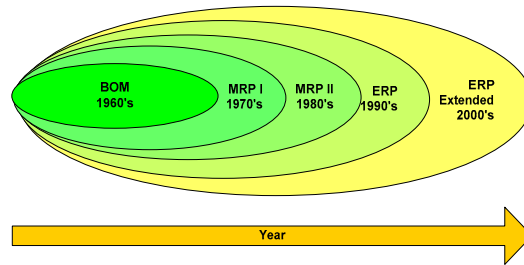


Figure 2: The Evolution of ERP

## 3. Maintenance management as a crucial function in implementing ERP

Nowadays, maintenance has been considered as a support function, non productive and not a core function adding little value to business. However, it has been noticed that many manufacturing industries have used various approaches to improve maintenance effectiveness [5]. Many companies have recognized that maintenance of assets have a critical part of the operational function. An effective maintenance strategy can significantly contribute through adding value to the production activities.

In 2001, Duffuaa et. al [9] described a generic conceptual simulation models for maintenance systems which consisted of seven modules. Those modules include:

1. Input module: this module supplies all data required for the simulation model.
2. Maintenance load module: this module represents and models the way maintenance

load is generated. The maintenance load is, in fact, the driving force of the whole model.

3. Planning and scheduling module: the input of this module is the maintenance load, i.e. a set of maintenance jobs. This module matches each job with the required resources then schedules it for execution.
4. Materials and spares module: this module is called by the planning and scheduling module to check for materials and supply availability before a job is ready to be scheduled.
5. Tools and equipment module: this module is called from the planning and scheduling module to check tools and equipment availability for maintenance jobs.
6. Quality module: this module is also called from the planning and scheduling to decide on the quality of executed maintenance jobs.
7. Performance measures module: in this module statistics are collected for calculating various performance measures.

ERP vendor such as SAP provides a variety of maintenance supports for its clients [13]. These supports include maintenance methodology, automated modification tool, change management system, online bug reporting system and helpdesk support [12].

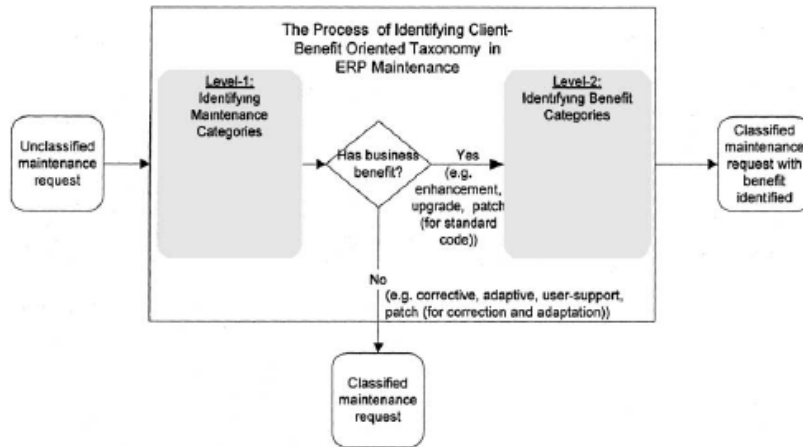
#### 4. Related Works

The most relevant research that related to this paper are described in the following. Celeste et. al [8] in their paper contributed detailed observations in an ERP maintenance environment such as: the ERP system does not only maintain internally originated by requests, but also implements maintenance introduced by the vendor; requests for user-support concerning the ERP system behavior, function and training constitute a main part of ERP maintenance activity; and similar to the software environment, enhancement is the major maintenance activity in the ERP environment. This paper [8] also explained about the objectives of implementing ERP maintenance such as:

- To keep the system running,
- To adapt to a changed environment in order to operate well,

- To provide help to the system users in using the system,
- To realize benefits from the system (best business processes or practices, improved system integration, operational cost effectiveness), and
- To keep the system a supported-version and meet the vendors requirements for standard code.

Celeste et. al [8] has proposed two-level ERP maintenance taxonomy named Client-benefits oriented taxonomy of ERP maintenance. The level-1 of this taxonomy helps in determining whether a maintenance request requires the level-2 of benefit categorization. The reason for this two-level maintenance taxonomy is that some ERP maintenance requests bring business benefit but the mandatory maintenance requests do not. Requests that could bring business benefits need to be identified and treated carefully to quantify the benefits, which can be simultaneously used to justify maintenance decisions. The process to classify an ERP maintenance request in the proposed maintenance taxonomy is demonstrated in Figure 4.



**Figure 3:** The process of identifying client-benefits oriented taxonomy of ERP maintenance.[8]

On the next paper [7] has identified the crucial factors for maintenance process standard adoption in the ERP context. There are two crucial factors found to explain the majority of the variances in that paper, it can be seen in Figure 4, those two environments are internal and external environments. Internal environment involves those factors under the control of and defines the characteristics within the ERP-client organization. On the other hand, external environment describes the

maintenance support and client’s satisfaction for the support provided by the external source i.e the vendor. The first crucial factor is related to external environment – the vendor’s maintenance support satisfaction. In particular, this is concerned with the availability of maintenance support from the vendor and whether it meets client’s maintenance needs of the satisfaction. Automated maintenance management tool, training and education on ERP maintenance process

management, overall satisfaction, and the availability of automated maintenance management tool and automatic record of all changes and modification provided by the vendor in assisting the clients to perform ERP maintenance activities. In the other hand, the second crucial factor is related with an

organization's internal factor, it is a management perception on the needs for basic critical software maintenance. Procedures for controlling changes and a mechanism for assuring that regression testing is done before, during and after making changes to ERP system, and the needs for training in these aspects.

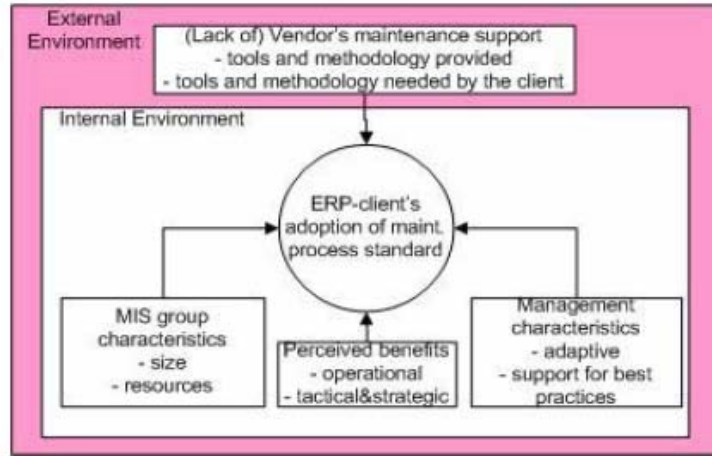


Figure 4: A preliminary factor model for ERP maintenance process standard adoption.[7]

Nikolopoulos et. al [10] carry out an integrating object-oriented maintenance system, focused on the effective modeling of information systems dealing with task of maintenance planning and scheduling. The proposed model by Nikolopoulos et. al [10] is divided into six parts. The divided parts are following:

1. Maintenance load;
2. Maintenance resources;
3. Maintenance planning and scheduling;
4. Work orders executing;
5. Quality control; and
6. Performance measurement.

The proposed model considers three types of maintenance:

1. Preventive maintenance: a work that must be carried out on a planned periodic schedule;
2. Emergency maintenance: work that must be done immediately; and
3. Diagnostic predictive maintenance or condition-based maintenance: work that must

be planned as soon as possible triggered by deterioration indicated by a monitored parameter.

It can be seen from Figure 5. That the maintenance management system must cope with the maintenance load. Maintenance load can be planned maintenance but sometimes it can be unplanned maintenance. Each time a maintenance load is created, a maintenance job request is generated. Then a work order is planned and scheduled. When a work order is completed, a set of quality control tests are performed. In case some of these tests are not satisfying, a request for a repetition of the maintenance job may be imposed. A successful quality control is followed by performance measurement and cost analysis. Finally, all data are recorded in the database and, as a result, the log data file of the maintained item is updated and new future periodic maintenance dates are calculated.

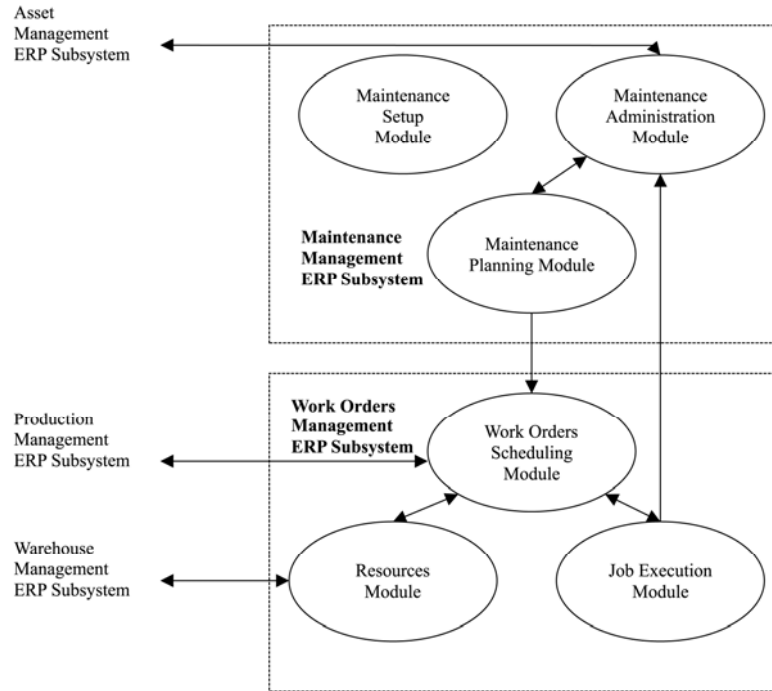


Figure 5: Structure of integrated maintenance management system.[10]

## 5. The Proposed Model

From the related work which explained above, all those researches have shared their ideas to contribute and propose the model of maintenance system that can be implemented into ERP system effectively. All of those models have many advantages to be implemented. Hence, in this paper we will try to accommodate all of the advantages in implementing those maintenance models into one compacted model.

In our proposed model, we have adapted Celeste et. al [5] statement that categorized ERP maintenance activities into five categories. Those categories are following:

- **Competitive advantage:** Increase and improve the capabilities and power to compete with other vendors.
- **Globalization:** Enhance information flow to and from customers, suppliers, and other business partners outside the enterprise, and flexibility to operate in worldwide areas.
- **Integrated system:** Improve the flow of information through centralized system, better system integration and communication among internal business processes.

- **Best practice/ business processes:** Improve business processes and practices, and business performance.
- **Cost reduction:** Cost decreased in activities related to business administration and processing, and system maintenance, and system support from the vendor.

From these categories, we have explained their objectives, type of maintenance activities that could be implemented to the system and function that potentially handle those activities. We can see the classification proposed at Table 1.

From the table shown at Figure 6. we have concluded that depending on the maintenance objectives and scope, a maintenance activity is not necessary contributing to a single benefit only. For instance, a request which primary is to provide better integrated system could also trigger, lead to and result in other benefits such as cost reduction in producing and manufacturing a product, facilitating the implementation of a function that is not possible before, enhancing the potential for operating in worldwide market, and/or providing the opportunities for new market.

Table 1: A Classification of maintenance activities divided into five categories.

Category	Primary Object	Type of maintenance that could be done to the system	Potentially handled by the following ERP maintenance function
➤ Competitive advantage	➤ Increase market share, business opportunity, customer loyalty, customer satisfaction, service quality	➤ Adopt advanced tech. / Add new functionality.	➤ Enhancement ➤ Functional upgrade
➤ Globalization	➤ Facilitate global access to customer, supplier and business partners	➤ Enhance information flow and system integration with customers, suppliers and business partners. ➤ Migrate Desktop Based ERP to Web Based ERP. (Optional)	➤ Enhancement ➤ Functional upgrade ➤ Platform migrate. (Optional)
➤ Integrated System	➤ Improve integration among internal business processes, enhance data management and accuracy of decisions	➤ Improve integration among application modules and processes in the system.	➤ Enhancement ➤ Functional upgrade
➤ Business process effectiveness	➤ Enhance efficiency and effectiveness in business processes and business performance/, and make the production cycle times shorter.	➤ Reengineer or redesign processes	➤ Functional upgrade
➤ Cost reduction	➤ Minimize cost (to the company)	➤ Upgrade to supported version ➤ Replace custom code with standard code	➤ Enhancement ➤ Functional upgrade ➤ Patch-maintenance (standard code) ➤ Technical upgrade

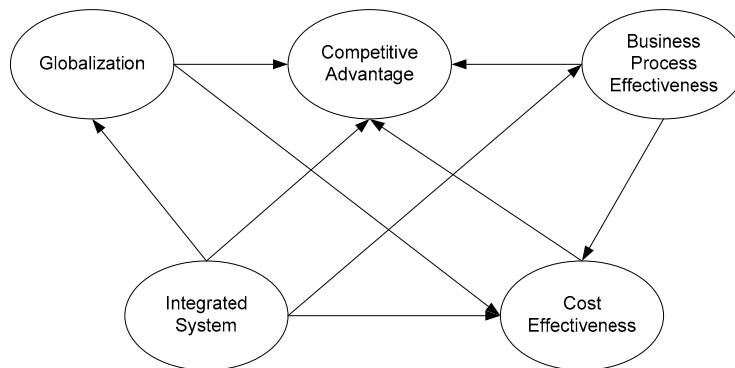


Figure 6: Connectivity among the maintenance activities categories.

The proposed model is an integration of client-benefit based maintenance strategy and data collection from classifying maintenance request. The framework shown in Figure 7. is identifying maintenance request from The client and then generating work order to be processed into the next maintenance steps depend on which category the request included. After work order completion, the

result must be evaluated in quality control and performance evaluation. If the result of evaluation is fail, then the process of maintenance will be returned to work order planning to design maintenance task properly. In this model, all of the information is stored in database that can be used at the new future periodic maintenance dates.

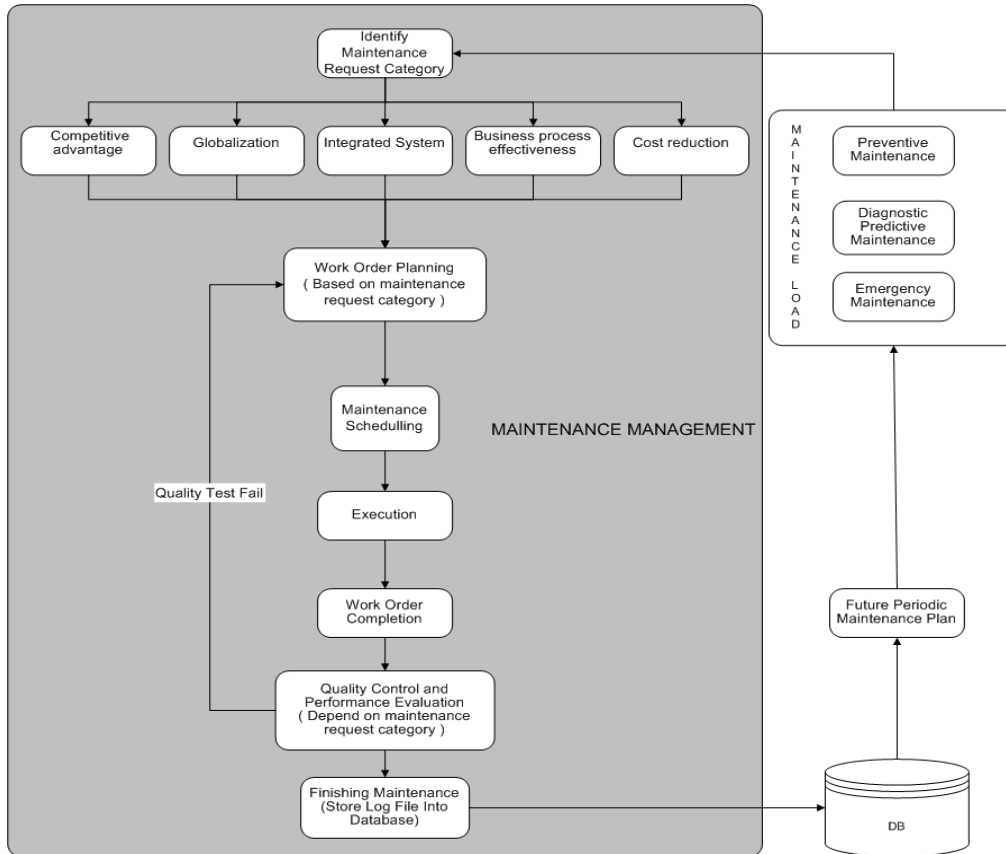


Figure 7: New Proposed model of Maintenance Management System..

## 6. Conclusion and Future Work

This paper proposed a new model of maintenance management system, presented an adaptable model for the maintenance strategy. The contribution of this model is that the specific methodology and provides an adaptable, generic model for any enterprise. With using this model, maintenance process can be more simple and effective because before doing every maintenance activity, The Maintenance Management System will check the log file which stored in database for the last maintenance. So, it can be the continuation from previous maintenance activity.

The author have started working to implement this model of maintenance strategy into open source ERP based on small medium enterprises in Malaysia. The main objective of the next model is scheduling maintenance in open source ERP with the approached model based on the modules of SME in Malaysia. Finally, we are expecting that our proposed model will impact to our project in developing open source ERP and hopefully this model can be more complete simultaneously in the next research.

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## 7. References

- [1]. Blanchard, B., Verma, D., Peterson, E., Maintainability: A Key to Effective Serviceability and Maintenance Management, John Wiley & Sons, New York, NY, 1995.
- [2]. <http://web.rollins.edu/~tlairson/ecom/erp.pdf>, Retrieved. 10 February 2008.
- [3]. Gupta, A., "Enterprise resource planning: the emerging organizational value systems", Industrial Management & Data Systems, Vol. 100 No.3, pp. 114-18., 2000.
- [4]. Chen, I.J., "Planning for ERP systems: analysis and future trend", Business Process Management Journal, Vol. 7 No.5, pp. 374-86., 2001.
- [5]. DTI, "Effective maintenance – a route to increased profitability", Managing Into the 90s Series, Department of Trade and Industry Publication, London, 1998.
- [6]. Siriginidi, S.R., "Enterprise resource planning in re-engineering business", Business Process Management Journal, Vol. 6 No.5, pp. 376-91, 2000.
- [7]. Celeste, S., Yuan, Z., Ping-Yu, H., Wen-Hsien T., "Salient Factors for Maintenance Standard Adoption in Enterprise Resource Planning Context: An Exploratory Study", Proceedings of the 39th Hawaii International Conference on System Sciences, 2006.
- [8]. Celeste, S., Guy, G., Taizan, C., "An ERP-client benefit-oriented maintenance taxonomy", Information Systems Management Research Group (ISMRG), Australia, 2001.
- [9]. Duffuaa S., Ben-Daya, M., Al-Sultan, K., Andijani, A., "A generic conceptual simulation model for maintenance systems.", Journal of Quality in Maintenance Engineering, Vol. 7 No. 3, pp. 207-19, 2001.
- [10]. Nikolopoulos K., Metaxiotis K., Lekatis N., Assimakopoulos, V., "Integrating industrial maintenance strategy into ERP.", Industrial Management & Data Systems, Vol 103 No 3, pp. 184-191, 2003.
- [11]. Mabert, V.A., Soni, A., Venkataramanan, M.A., "Enterprise resource planning: common myths versus evolving reality", Business Horizons, pp. 69-76., 2001.
- [12]. Ng, C.S.P., "Factors Driving Enterprise Resource Planning Upgrade Deferring Decision: A Transaction Cost Economics Perspective," Proc. International Conference on Accounting and Information Technology (ICAIT), Taiwan, pp. 840-853, 2005.
- [13]. Ng, C.S.P., Gable, G.G., and Chan, T., "A Client Benefits-Oriented Taxonomy of ERP Maintenance," Journal of Systems and Software, vol. 64, No. 3, pp. 87-109, 2002.
- [14]. Priel, V., "System Maintenance Organization", MacDonald & Evans, London, 1994.