ENTERPRISE RESOURCE PLANNING SYSTEMS

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ABSTRACT

The paper mainly focuses on the Enterprise Resource Planning (ERP) system which is commonly used in most businesses and organization to ensure a centralized communication system. The need to utilize the ERP system has been well illustrated throughout the report as ERP improves interdepartmental communication and ensures that production cost are reduced to affect the final cost of products. The paper presents different concepts of the ERP system, starting a detailed definition of the ERP system concept and the use of the system in any organization. Different ERP modules are also presented with illustrative figures that show their working, command processing and different stages that are included in creating the ERP system. The critical Requirement Engineering for ERP system concepts has also been analyzed to ensure that the different issues that affect the ERP system functionality and implementation are highlighted and addressed effectively to ensure the ERP system is up to date and functions effectively as per the demands of the organizations. The paper clearly points out the aspects of ERP with case studies based on past empirical papers and literature review. Future work and implications are mentioned in the paper.

I. INTRODUCTION

In the computer science and business world, Enterprise Resource Planning (ERP) is referred as a computer software that offers solutions to businesses through integration of business information data and functions to a single system that can be shared within any company. Initially, ERP was mainly based on the production and, manufacturing planning systems that were commonly used in the manufacturing industry. However, in the 1990's, ERP started to expand its scope to other back office functions in the production planning, finance and human resource. The development of ERP has resulted in this software solution incorporating other different business extensions like the customer relationship management and the supply chain management to ensure increased competitiveness of this software solution. ERP is mainly developed to increase operating efficiency through cost reduction and improving business processes. ERP provides the different departments in any organization that have diverse communication needs with a system that share information effectively and improve departmental outputs. This results in the ERP system improving and increasing cooperation between the different business units within an organization. A single transaction system is created by the system through streamlining the flow of data within the different aspect of the company like the sales, department, human resource department, delivery department, customer care department etc. Integration and standardization of data and process tends to allow any company to centralize its administrative activities, reduce cost on information system maintenance, and improve the ability of deploying new information. This has resulted in the ERP system becoming the backbone of most business intelligence used in organization through providing mangers with an integrated view of the entire process of business. The ERP system is commonly designed to adapt towards the new business demand concept. The non-ending technological advancement in the field of computer science has led to increased ERP complexity, and hence companies are required to upgrade their system on a regular basis. This has also led to most ERP vendors being forced to provide the

opportunity of updating the ERP system and aligning them with the current perceived best business practices to ensure that the business meets the changing needs quickly.

II. BACKGROUND OF THE RESEARCH

Enterprise Resource Planning (ERP) as a system has evolved to different software packages used in supporting coordination of various actors within a company (Botta-Genoulaz, Millet, & Grabot, 2005). The current ERP systems have modules that are not only aligned to the management of materials, but also aligned to human resource management, accounting and other different functions that are considered to be supporting the entire business operation. The development on the role of ERP systems has seen the system including a cross-organizational coordination. The cross organizational coordination concept entails the system use by various independent and nearly independent businesses. This has a represented a key issue within Requirements Engineering (RE) in ERP on a cross-sectional context when finding the perfect match between business coordination requirement and the ERP application modules (Alvarez, & Urla, 2002). The implementation life cycle of ERP systems mainly entails the Preparation of the Project, Specification/ Requirement Engineering, Realization, and Final Preparation that leads to Go Live and the Support Stage. RE mainly involves the identification of the various stakeholders within the ERP system implementation, and identifying their specific needs to model and document them for effective analysis, communication, and implementation. The RE stage is one of the most crucial and costly stage within the ERP implementation process. The business process must be aligned with the ERP systems at this stage (Mohan, & Chithralekha, 2007). There are three crucial activities that constitute the RE process: eliciting requirement, enterprise modeling and negotiation on the requirements. Eliciting requirement is a process that involves searching, communicating, and validating the different available facts and rules concerning the business. Enterprise modeling represents and analyzes the entire business data and process. Data modelling and business process are the vital point s of validating and communication enterprise business requirements (Botta-Genoulaz, Millet, & Grabot, 2005).

Different techniques in process modeling have been developed to ensure a business has been effectively modeled to suit its ERP system. The modelling objective is to capture the various business aspects within the requirement modeling phase. Requirement negotiation entails the data architectures and validation process, data issues and resolving process, and requirement prioritizing. The RE phase output is documents and models used in the realization phase to undertake some configurations. The model being process models tend to focus on the control aspect with little attention given to the interaction and flow of data (Botta-Genoulaz, Millet, & Grabot, 2005). Configuration on the other hands entails the selection of the appropriate tables and parameters that will reflect the organizational needs. This means that the configuration perspective is seen from a data point of view, thus creating a deficiency in the RE phase output and the configuration process input requirements. This difference is only minimized through focusing on the data interaction and flow along the control flow process. The process model can be used to capture the data interaction and flow. The paper will mainly focus on the existing RE methods that are utilized by ERP vendors, and analyze if the vendors use a modelled data interaction and flow or a separate data model (Botta-Genoulaz, Millet, & Grabot, 2005).

III.   THE PROBLEM STATEMENT

How effective is ERP system when being utilized in the major organization to offer support to communication and cost reduction? What problems are expected to be encountered within the use and application of the ERP system? And how does the ERP system work?

IV.   RESEARCH SIGNIFICANCE

The research is quite crucial as it offer better understanding on what ERP system are and how they are utilized in most successful organization. The research also presents the basic ideology behind the ERP system functioning through using the basic procedure undertaken in most firms on the order and sales basis. Hence the research will act as a source of information to Managers, and firms that do not have

any ERP system software within their organization and to anyone who needs critical information of what ERP system are and how they function.

V. RESEARCH RATIONALE

The research starts by defining and offering a thorough explanation to the ERP system as basic concept in computer science. Collected information that include the different processes of the ERP system will be highlighted through algorithm and process charts to show the significance of the paper to modern application of the system to organization that need to improve their performance while cutting down on communication and cost. Best ERP system utilized by most companies will also be presented.

VI. RESEARCH OBJECTIVES

The ERP system is commonly designed to adapt towards the new business demand concept. The non-ending technological advancement in the field of computer science has led to increased ERP complexity, and hence companies are required to upgrade their system on a regular basis. This has also led to most ERP vendors being forced to provide the opportunity of updating the ERP system and aligning them with the current perceived best business practices to ensure that the business meets the changing needs quickly.

VII. RESEARCH METHODOLOGY

This section provides insights on the research methodology and the most appropriate methods used in the carrying out of this study. It consists of sections covering the research purpose, study design, empirical evidence, theoretical modelling, ethical considerations, and challenges encountered in the course of the study. Research methodology
The research methodology manly involves the collection of data and information from different source through literature review. This involved the use of relevant peer journal publication and books that have undertaken both quantitative and qualitative research to come up with the different aspects and explanation of the ERP system.

VIII. RESEARCH PURPOSE

This research aims at showing the importance of ERP systems tools in corporate governance. It being a descriptive research, attempts to provide a description of different aspects that have a correlation with the situations or events within an organization. Therefore, the purpose of having such a study would be to generalize the outcomes so as to develop theories. Further, it takes the form of a descriptive research as the researcher only possess adequate knowledge about the problem in question and there is limited intention to find out the relations between the causes and effects of the problem. It adopts this approach as secondary data will be involved in the investigation of the problems to be solved by this research study. For this study, secondary data will be derived from the literature review section and theories from these used to support the empirical evidence.

IX. STUDY DESIGN

This study incorporates the theoretical study design and the empirical research design. The theoretical study design involves the creation of different models while the empirical research design will involve the use of the scholarly articles and books as a means of lending credence to the assertions therein. The pros of adopting such a design is that it takes less time in adoption and implementation, is cheap and makes it easier to compare data in order to come up with reliable and valid findings.

X.   RE TECHNIQUES FOR ERP

During the RE phase, interviews are sometime used to gather information that is considered useful during the ERP implementation. Unstructured interviews are known to generate narratives that are critical in the analysis of the pragmatic view on the functioning of the organization. ERP implementation within small and medium enterprises commonly uses structured interviews as the main capturing requirement method (Alvarez, & Urla, 2002). In order to understand the structure of an organization, a standard set of questions is used to determine the following:

- The industry type
- The services and products provided by the organization, and taking into consideration the cost and complexity of the implementation.
- The employee number
- The mission statement as the ERP methodology is expected to math with the mission
- The structure of the organization where ERP will be used to map the organization
- Businesses relationships
- Accounting profile which ERP will set the required information

In an attempt to understand the entire organization process, some questions on Material Requirement Planning must be asked as follows:

- How the purchase order is created
- Is there any decentralization in purchase?
- Are the sales order taken to account in MRP?
- Are the requirements nature's high or seasonally variable?
- Is human intervention allowed or he forecast algorithm is automated?
- Is the MRP taking input from order policy, hand stock, demand forecast, safety stock policy etc.?
- Are there multiple distribution centers?

Collecting this information will ensure that an organization MRP process is partially captured and hence making work easier during the ERP implementation process.

XI.   OBJECT PROCESS MODELING (OPM)

Object Process Methodology (OPM) is a technique of creating Object-process diagrams (OPDs) that are used in capturing the business requirements while aligning the various business processes to the ERP software. The dynamic and structural aspect of a system is captured while capabilities from process and object oriented paradigm are inherited by OPM (Botta-Genoulaz, Millet, & Grabot, 2005). Entities that represent objects and process are the main building blocks used in OPM, where the relationships between the different entities are presented as links that are procedural or structural. Links and entities are OPM elements that are of high level or even abstract and detailed in a different OPM to develop a top-down requirements representation. Object generalization is seen as a thing since it can be transformed by the provided process. Through transformation, some new objects can be developed, while the existing objects can be altered (Botta-Genoulaz, Millet, & Grabot, 2005). The procedural link describes the process transformation and enables the various objects. Since they connect the object and the process, they tend to describe the system behavior. Static relationship that is presented between objects is illustrated through structural links, where the relationship is in terms of Exhibition, Aggregation, Classification, and Generalization. One entity is seen to provide input to a different entity only when a certain condition is true, where this link is considered as a conditional link (Alvarez, & Urla, 2002). In the situation where a process needs an entity for execution, the process ad entity will have to be linked through an instrumentation link. An object or entity may start a process once its state or value changes. This situation will require the object and process to be connected through an event link. The changes in a particular object are depicted by the effect link (Botta-Genoulaz, Millet, & Grabot, 2005).

An example of an OPM is provided below on a Sales and Order process. This OPM is divided in three sections that are Billing, Ship Goods and Create Sales Order. In this example, it requires customer and material data, and customer order in executing the process. The data elements are presented as objects

and hence an instrument link is used between the process and the object. This results in modifying the sales order and an effect link is used between the Create Sales Order process and the Sales Order. Since customers credits need to be verified undertaking a Create Sales Order, a condition link is used.
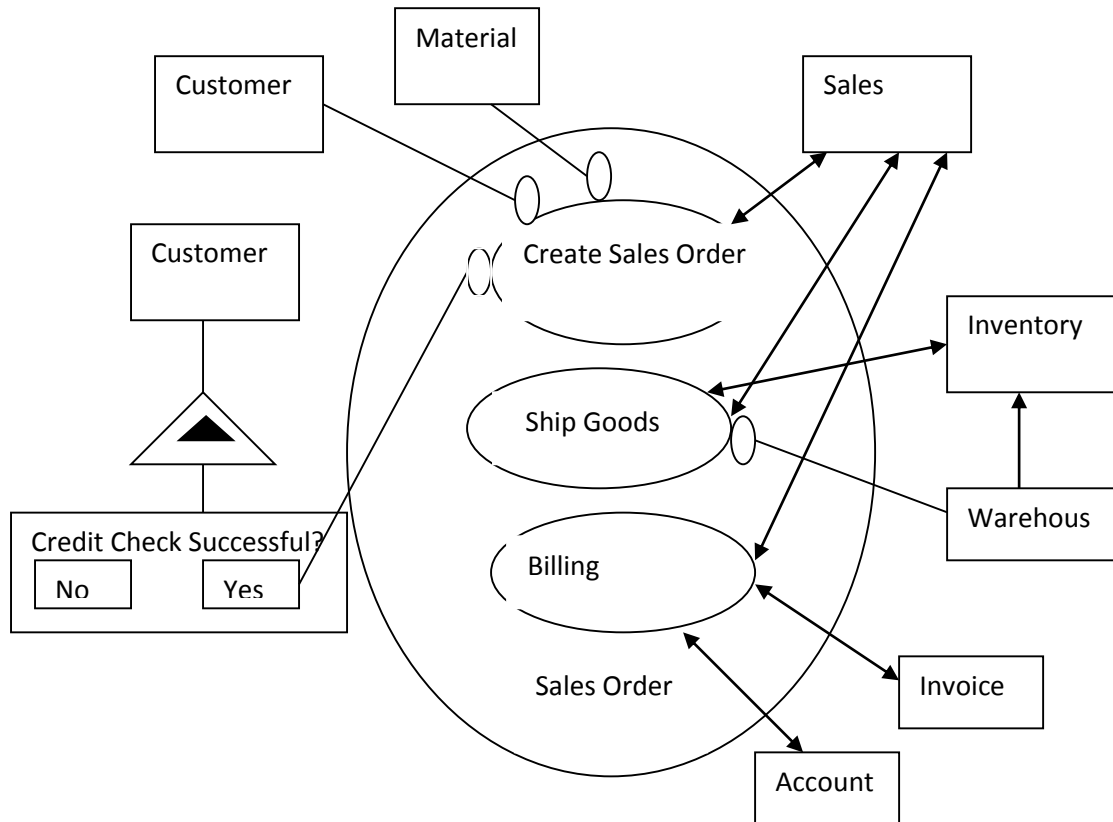

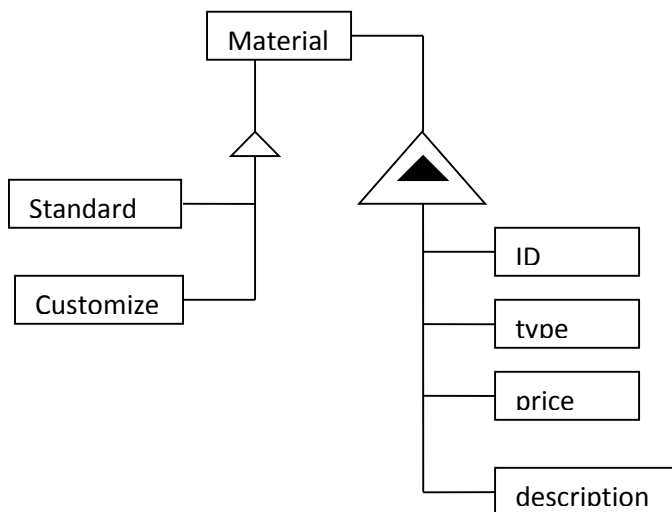**Figure 1:** Illustration model for the Top level OPM on Sales Order Process

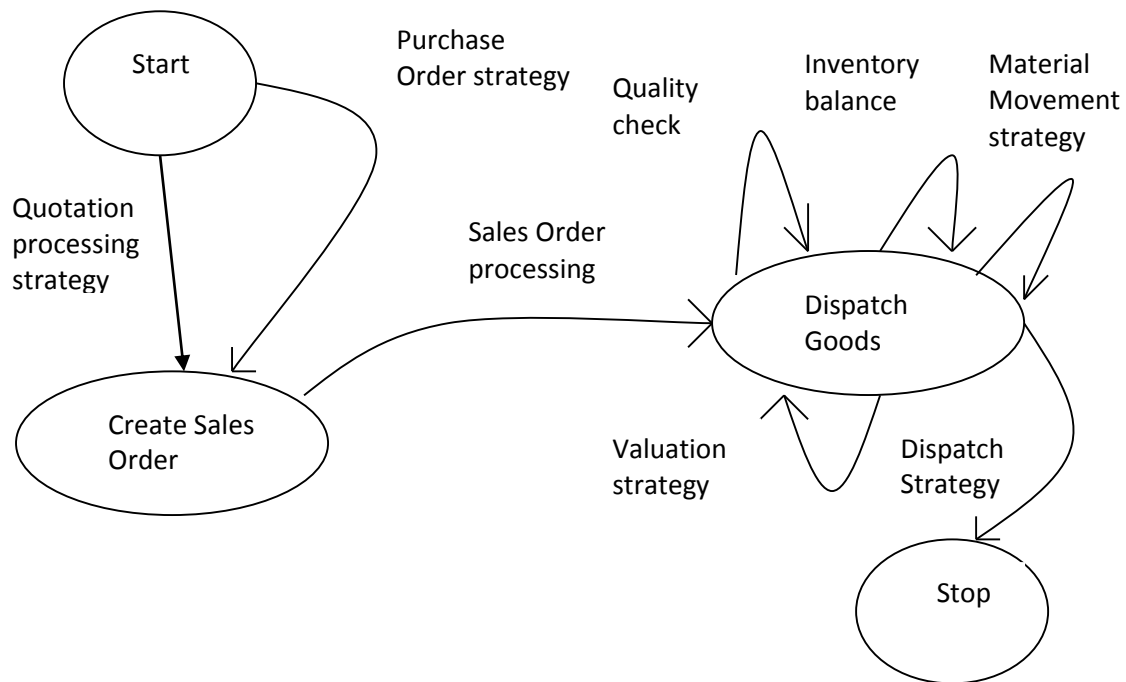**Figure 2:** Description on the Object material

XII. GOAL MODELING

Figure 3: Sales and Order Process Map

A goal oriented approach tends to employ the idea of a map when representing the main strategies and goals. The map mainly represents the intentions of the business or organization through a process model.in this case, the map is defined to be a labeled directed graph that have intentions which are indicated by nodes and the strategies presented as edges placed between intentions. Intentions are goals that are referred as task within the model, where every map has two special intentions, which are start and stop (Scheer, & Habermann, 2000). A strategy is used in achieving an intention, where the map can easily be refined to ensure that they express different tasks at different complexity levels and its recursion tends to allow customization of different abstraction level. From figure 3 illustrated above, the abstract forms which are Order and Sales process have two intentions which are to *Dispatch Goods* and *Create Sales Order*. The manner in which the sales order id developed and created results in becoming the strategy. In simple terms, the Sales order is created either through *purchasing order available* or *quotation processing* strategy. The second key intention is Dispatch Goods (Soffer, Golany, & Dori, 2005). The map also dictates checking the material quality which is undertaken when deciding the material movement mechanism. The map then allows the material to be physically moved with the balance sheets being updated. In an EPC diagram, this can be presented as Inventory Management, Quality Check, Material Movement Strategy, and Valuation strategy. There also contains many strategies that are bundled up under a single strategy during the implementation process of the ERP system under ER (Luo, & Strong, 2004).

XIII. SAP MODELING TECHNIQUE

The requirement specification phase output in SAP is considered the Business Blueprint as it is the detailed documentation of the various functions and data view, and the control view that is represented by EPC process model. The data view in this case is either the Structures ER or an Extended ER diagram.
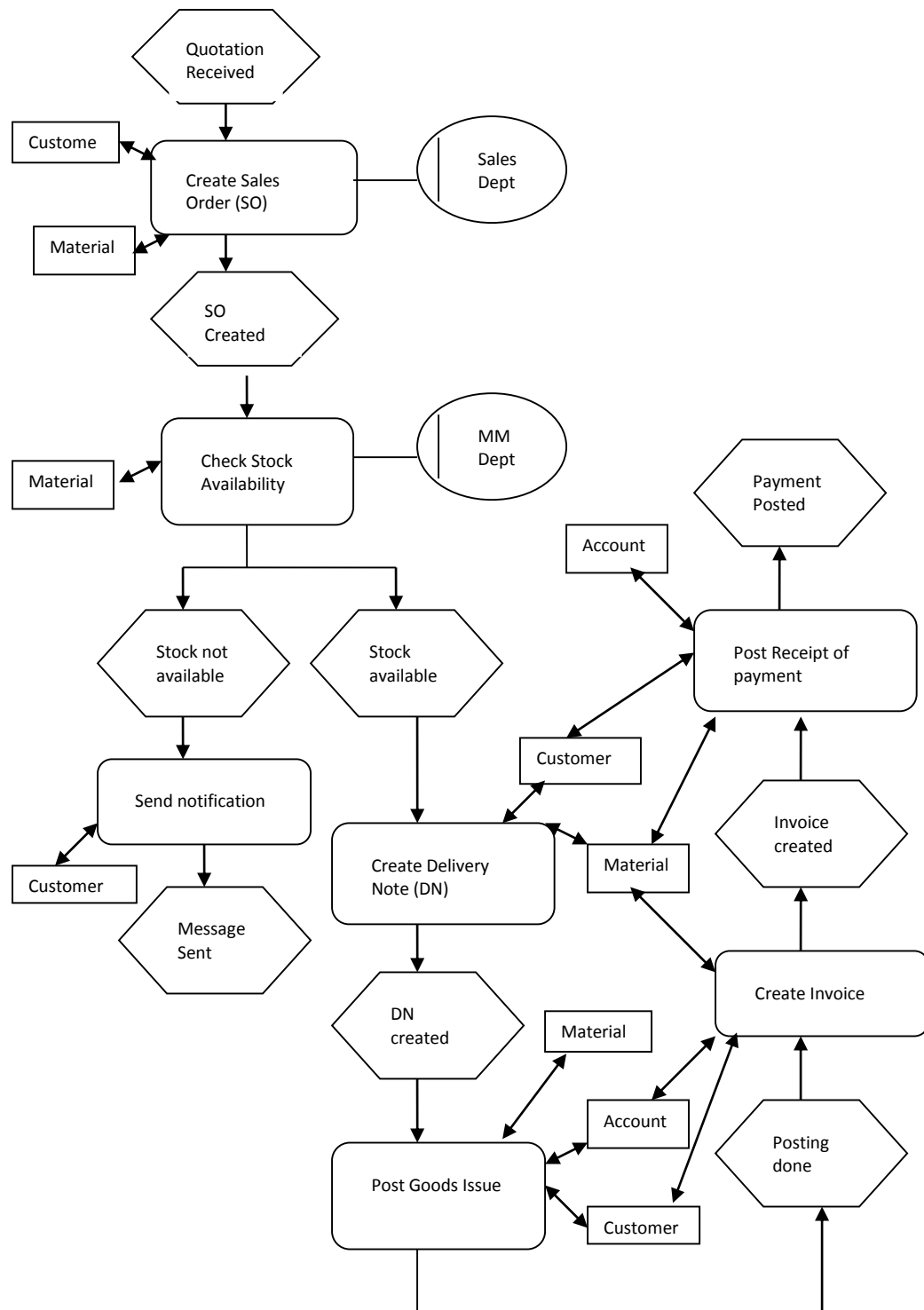
Figure 4: Sales and Order Process illustration using an EPC diagram

A Question and Answer database assist the EPC process model in eliciting different stakeholders'
views on the entire process. The EPC model is quite crucial in the EPR system implementation and
success as it captures the functions and tasks, events, organizations of the different task, and
communication aspect of whole business organization process. Activities or functions are considered
to be the basic building blocks pf an effective EPC diagram, and they are triggered every time an
event occurs (Scheer, & Habermann, 2000). Every time a functions completes, an even is known to
occur, which translate to the business process Control flow being captured as an alternating function
and events sequence. The events notation is presented as hexagons and the functions as rounded

rectangles. Real world objects like resources, materials and information that may be used by a function as inputs or produced as output are represented in the process by rectangles. In this case, they represent information flow undertaken between the functions where output object are created or changed, and input object is read (Soffer, Golany, & Dori, 2005). An oval is used in representing the organizational unit performing that activity. In the figure illustrated above, the Sales and Order Process of a business organization is represented through and EPC diagram. An even which is marked as *quotation received* is seen to trigger a function referred as *create sale order*, which later creates the event referred as *sales order created*. A *check stocks* functions is triggered by the event, which then results in one of the two exclusive events referred as *stock not available* or *stock available*. Sales will be made or a notification will be sent to a client depending on which event occurred. However, the two events cannot occur at the same time and this ensure the effectiveness of the system and the entire ERP system operation (Daneva, 2003).

XIV. RE TECHNIQUES ANALYSIS

Documentation and models are commonly considered to be the RE phase output are also utilized for configuration purpose. In the realization phase, the ERP system configuration is seen to be the selection of the appropriate attributes and activation of the relationship between the various tables included in the ERP system database (Soffer, Golany, & Dori, 2005). Enabling or disabling of the different parameters within the tables is undertaken according to implemented processes. This results in the configurations require to view the entire process functions on a data perspective. The requirements that are captured within the documents and models in the requirement specification phase is expected to contain a description of the entire process used in terms of interrelationship and data (Scheer, & Habermann, 2000). During configuration, the following process and data aspect are considered crucial and extremely significant as they are modeled while capturing requirement:

Entity type: an object used to store data is referred as an entity. There exists a relationship between all provided data entities or elements. In the situation where entities are used in the definition of a relationship, they are considered to be regular entities, while those that are considered to be results of relationships are known to be modified entities. During configurations, regular entities with their relationship are deliberated on (Soffer, Golany, & Dori, 2005).

Relationship type: data objects related to each other and their relationships are used in depicting the decision to be made on configuration (Scheer, & Habermann, 2000). The decisions are optional or mandatory.

Business processes: there are rules that guide the business processes which are Integrity rules and Activity rules. Consistency rules in the business process tend to define the data base integrity constraints. Activity rules on the other hand prescribe the operations and actions sequences that should be performed. These rules also incorporate any information or process constraint required for specific activities. Cardinality is also used in expressing business rules. The maximum number of entities to be associated with others in a relationship is expressed by cardinality (Daneva, 2003). In other words, cardinality expresses the different constrains within the number of occurrences in an entity when analyzing the different RE techniques to ascertain if they capture the interaction and data for the process. If the captured data is modeled to be used for the configuration purposes, it is required to meet the configuration techniques requirements. In any system, narratives are considered to be good information source since they can convey interpretation, meaning, and knowledge about a system. However, analyzing such description is considered to be quite extensive and involving task. The narrative interpretation also varies from every stakeholder; hence it is only used as an elicitation requirement method. A structured interview is used as the best approach using some predefined questions (Daneva, 2003). Even though this method is commonly used for requirement elicitation, using the document for configuration may also presents some difficulties as some crucial aspects may miss out. This generally means that a modeling technique is expected to be used in converting the captured data through a structured interview to the model, and the model can be used for further reference.

The OPM technique is an extremely convincing method to capture the requirement for the entire ERP system process. This method represents all the data objects needed in accomplishing a process, while depicting the process attributed through structural links, but does not illustrate the relationship

between objects (Hedman, & Borell, 2004). This presents OPM as a process modeling technique that is similar to EPC techniques, but has some added features that represent the object. Since the technique in seen to represent data objects, it is analyzed from the configuration requirement view point. When configuring the ERP system on a data modelling perspective, the technique is seen to be inadequate as it lacks the means to ascertain the entity's regularity or modification, and there exist no qualification to show nature of relationship in terms of it being optional or mandatory. Using the map concept in modeling the ERP process is perceived as process centered, as the strategies used are determinant of the manner in which the task are accomplished. There lacks a mechanism to represent all data elements useful for the task, and hence its evaluation cannot be undertaken to ascertain whether it meets the specific configurations requirements (Hedman, & Borell, 2004).

The EPC modeling techniques commonly used by SAP, and models organizational elements and data elements, along with control flow to accomplish a specific process. Interrelationship between the data elements re not shown but can be shown through a data model used alongside the EPC diagram. The SAP techniques use EER in creating a data model. EER and ER diagrams show the entities relationship, where some entities are mandated to complete a specific activity while other are a result of those activities (Rolland, & Prakash, 2000). Looking at this from a data perspective, all the entities that are required to complete the activities are referred as persistent (master) data, while entities resulting from the activities are referred as transactional data.
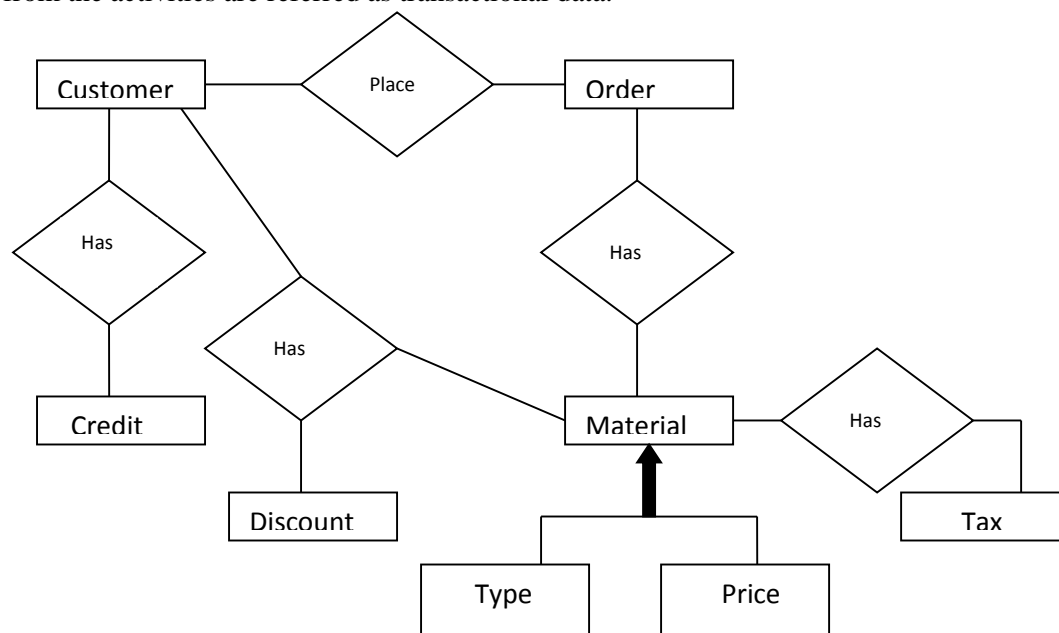

Figure 5: ER diagram illustrating Create Sales Order

Configuration modeling involves setting up the master data with its validation or rules. This makes it quite necessary for the distinction of master and transactional data. However, EER contains no construct in showing the distinction. The EER diagram does not show the various distinctions, but tends to represent a small number of rules and constraints. Activity rules representation cannot be done through the EER diagram; hence the EER diagram is concluded not to fulfill the configuration specifications (Davenport, 2002).

XV. ACTIVITY BASED COSTING SYSTEM

A time driven ABC costing system can be extremely beneficial if implemented in most businesses since it will increase positive business performance. The implementation of the *Time driven Activity Based Costing System* will involve a model that entails all the actual operation and complexities of an organization. Since a company has many operations like shipping and deliver of products to customers all over the world, a single operation can be used in the implementation of the Time Based ABC costing system (Daneva, 2004). A single operation like "ship order to the customer" , the

company may see it fit to recognize the total cost difference in events when the product order will be shipped in full truck, commercial carrier, overnight express, or by less-than-truckload shipment rather than just assume a constant cost for every order shipped to the customer. The system will allow for this analysis and show the best solution according to time and cost of the activity. The time based ABC costing system will be required to allow both automatic and manual data entry in standard and expedited transaction forms. The Time Based ABC costing system provides different arrangements in shipping since numerous new activities have been added on the model which result in increasing its complexity. The Time based ABC costing system will ensure that a business has more accurate information costing which will tend to be extremely organized under different time based activities. The company will be able to align its customers cost and product more closely with the consumption of resources. All the estimates used in time Based ABC costing system are management responsibility where the model allows the company to produce accurate estimates as required.

The Time Based ABC system is easier to maintain as opposed to other system and the traditional ABC system. This will always come in handy since most companies try their best to reduce operation cost in order to reduce the product cost to its customers. The reliance of the Time Based ABC costing system on the ERP system capabilities enables it to have easy maintenance (Daneva, 2004). Total cost reduction can be achieved through low or reduced maintenance cost, which every organization strive to achieve. The ERP system within the Time Based ABC costing system enables the system to allocate some support costs to different customers and products. The implementation cannot be undertaken without a uniform agreement and effort of all the stakeholders of this system. This is mainly due to the effort needed and the time of implementation. As far as this system will require the executive management total support, employees' attitude on the new system should be determined and set in the right direction for the overall success of this system implementation.

The Time Based ABC costing system will ensure that an organization has a competitive advantage on the current market space since it will reduce the time spent before a customer order request is received and the delivery time. Customers tend to show some loyalty to businesses that process and deliver their products in the shortest time possible. The Time Based ABC costing system reduces the order processing time and hence ensures that orders are approved and delivered to the relevant destination in the shortest time possible under the lowest cost possible. The system also reduces the total cost attributed to the company's operation which will result in reduced product prices and added competitive advantage (Daneva, 2004).

Time driven ABC costing system that operate services that are provided online is quite efficient and less time consuming as opposed to the traditional channels. The main difference between the online service provision and the traditional service provision is the time and location factor. Under the online service provision, the Time Based ABC costing system can undertake a transaction from a customer who is at a different geographical location using the least time possible (Robert, 2007). The traditional system will requires the customer to be present at the company stores to make an order hence time consuming. The Time Based ABC costing system is extremely effective and useful on online services as opposed to the traditional channels of business.

XVI. AN ERP INTEGRATED MODEL APPLICATION

HR Component Enhancement with Personal Appraisal model
Using an appraisal formalizing model that meets the requirements of some feature commonly detected when analyzing ERP problem domain; an application of the ERP integration model can be archived. Essential parameters on employee evaluation within an organization will include:

- Enrolled employee amount
- Vacant positions that are currently available
- Working functions of employees
- Hierarchy-based corporation structures of the organization/business are combined.

Assuming that A and B are sets within the system
B^A will represent the mapping to B from A:
$B^A = \{f|f: A\text{->}B\}$.
Matching B^A with the mapping:
$\|°\| = \{f \mid f\ B^A \times A \rightarrow B\}$, where $\|°\|$ is the evaluation function. Then:

$||°|| = (<f, x>) = f(x)$ which can be presented in the form

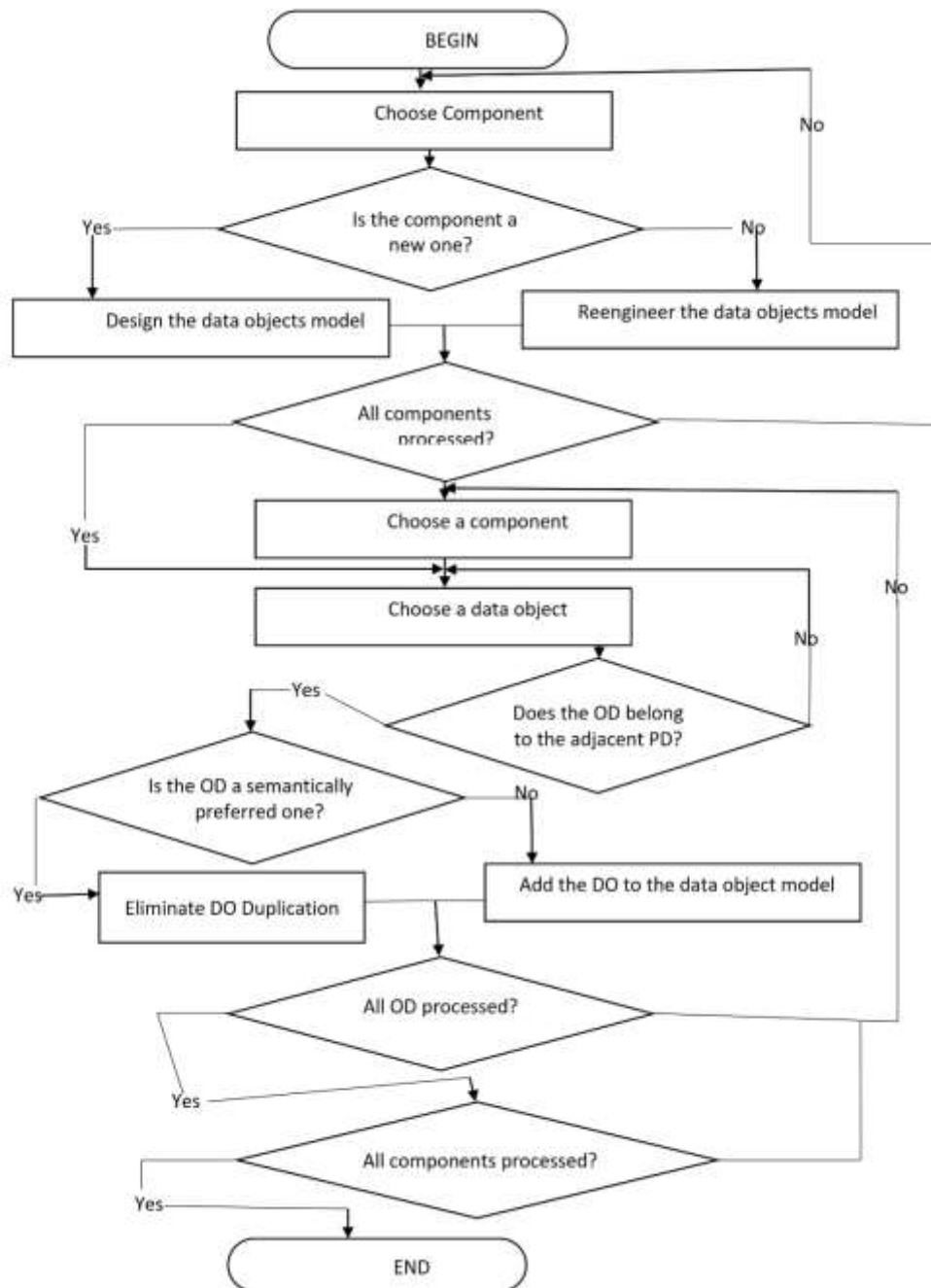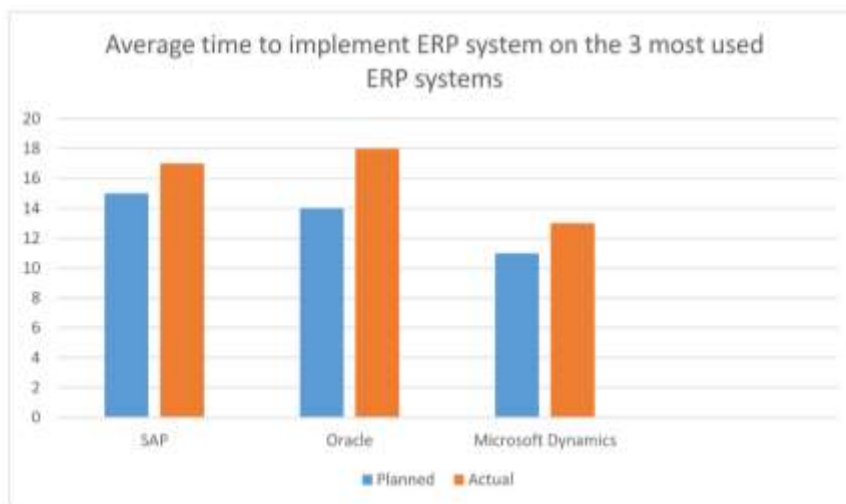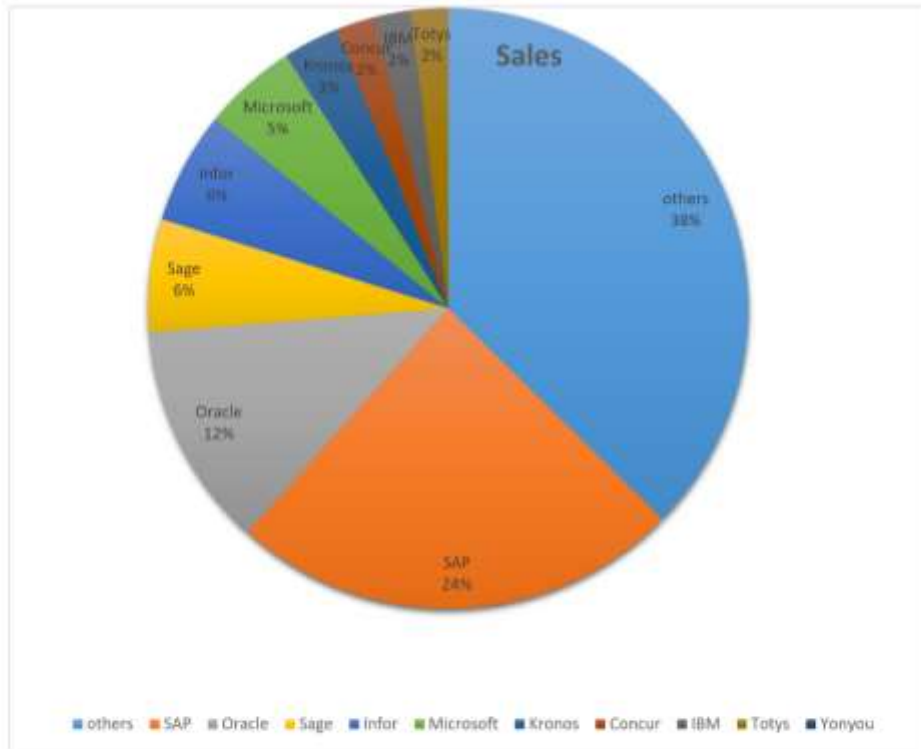$||<f, x>|| = f(x)$ is true.

Building the model of the semantics network language, we will consider an ordered pair of the products which will be in the form:

L=<R,C>,

where $R=\{R_1,R_2, R_3,……\}$ will represent the set of predicate dyadic predicate symbols while $C=\{C1,C2,C3,……\}$ will represent the set of constant.

The model formulae corresponds to some simple frames where the terms signifies problem domain individuals. In this situation, a frame evaluation procedure can be constructed using the evaluation function introduced $||°||$.

XVII.   ETHICAL CONSIDERATIONS

This study was conducted under the ethical considerations of a research study, firstly by seeking the permission of relevant authorities. The literature review contains peer reviewed articles and books that have been consistently used for scholarly purposes. These texts have been referenced in the bibliography in order to conform to policy against plagiarism.

XVIII.   CHALLENGES ENCOUNTERED

This research study encountered challenges such as the possibility of the literature review not correlating with the findings of the modeling and empirical evidence. It was also time consuming to obtain the peer reviewed articles on the topic as researchers continue to explore the field of risk management and corporate governance. The sum total of these made the study take a considerably more time in its accomplishment.

XIX. FUTURE WORK

The research clearly illustrates the importance of the ERP system as it considered a critical tool within the running of any major organization that has different departments and processes. Future research is needed to analyze the different processes used in the ERP system and propose a single process that will ensure the ERP system is always updated to the current business demands and changes, as most ERP system have to be manual updated to meet current demands. ERP system should have an intelligent aspect that allows automatic updating of current market needs and demands.

XX. CONCLUSION

A data modeling techniques is hence required to be used with a process modeling techniques attributed to RE towards the realization phase in the ERP life cycle. Time and effort used in the ERP implementation will be reduced through this process. The paper has illustrated the gap present within the modeling techniques in the RE phase. Incorrect configurations, enormous effort, and huge implementation cost and time are caused by this gap. From the illustration, a conclusion is reached outlining the importance of using a single modeling language in the requirement gathering and during configuration.

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