



# A SYSTEM DEVELOPMENT METHODOLOGY FOR ERP SYSTEM IN SMEs OF MALAYSIAN MANUFACTURING SECTORS

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## ABSTRACT

Improvement in the effectiveness and competitiveness of Malaysian SMEs (Small Medium Enterprises) in the global market is very important, because these SMEs an essential role in the Malaysian economic growth. The ERP (Enterprise Resource Planning) is a significant tool to increase the effectiveness and competitiveness the SMEs. The ERP enhances the efficiency of the whole business operations in an organization and increase the optimal income. Nevertheless the due to various reasons the implementation of the ERP has not been successful in many organizations and hence its success rate of implementation is quite low. A lot of researchers have identified the factors that constitute towards the successful implementation of the ERP. It has been identified that majority of the SMEs tend to refrain from adopting the ERPs due to the cost and complex implementation factor. In this paper, the authors have developed and proposed an efficient methodology that enables successful implementation of ERP system in SMEs. The aim of this paper provides a platform to accomplish the objectives of ERP system. However for the purpose developing ERP systems to suit the needs of Malaysian manufacturing SMEs a new methodology is required. Hence this paper proposes a methodology that comprises two main methods: (1) preliminary study which includes two quantitative questionnaires, current status questionnaire and readiness assessment questionnaire; and (2) system development method which includes four phases that make up the ERP system development method are: analysis and definition, design, construction, and evaluation stages

**Keywords:** *ERP System Development Methodology*

## 1. INTRODUCTION

In Malaysia the SMEs constitute a part towards the economical growth, as compared to the other businesses [1-2]. As one of the contributors towards the growth of Malaysian trade and industries, the SMEs have contributed in the country's overall production network. SMEs are also evenly contributed extensively to the performance of Malaysia economy even though large enterprises are explicitly monopolized and have overshadowed the visibility of SMEs in most countries in terms of net profit and assets, [1].

Since SMEs in Malaysia are now competing in the fast-growing challenging market environment, they are aimed at moving forward and upgrade their business operations to the optimum level. The ERP system would be one of the best ICT tools that will help the SMEs in handling their business operation and increase efficiency in decision making. However the adoption of ERP would be a very

costly aspect to SMEs [2-3]. The issues involving in the adoption of ERP among SMEs in Malaysia will be discussed in this paper later.

ERP can be defined as software, which integrates the whole functions of an enterprise into one unified database and is considered as a business solution. It integrates all the functions within the enterprise such as: production planning and supply chain [2]. Thus, SMEs also has seen this as an opportunity for them to improve their business processes in line with many of large organization as they have invested in ERP implementation to seek into the competitive advantages and remain solid in the face of globalization.

The objective of this research paper is to discuss the previous works that have been published related to the development of ERP system for SMEs and suggest suitable methodology to develop ERP system that is compatible with the business

functions of the Malaysian manufacturing SMEs and fulfils its needs and requirements.

As for the future work ERP system will be developed based on the proposed methodology which can be adapted to the requirement of manufacturing SMEs in Malaysia. This model or prototype will be evaluated and tested to several selected manufacturing SMEs around Malaysia.

## 2. REVIWING OF ERP DEVELOPMENT MODELS

This section reviews three approaches to developing an ERP system for SMEs.

### 2.1 Research Methodology for Assessing Malaysian SMEs perspective on ERP

Ngadiman et al [4] proposed a model of an ERP system appropriate for SMEs based on the in-depth study of ERP adoption issues of the ERP system in Malaysian SMEs. Surveys and field study were conducted in research work to assess the perspective of Malaysian SMEs on ERP.

The methodology proposed by [4] is a combination of qualitative and quantitative research. A survey by questionnaire was conducted to find out the characteristics and requirements of the ERP system in Malaysian SMEs. Interviews and fieldwork were also conducted to get a better understanding of the operation business processes by SMEs. The prototype of one ERP module was developed based on the data collected from the questionnaire and field study. The research strategy for the study has been summarized in figure 1.

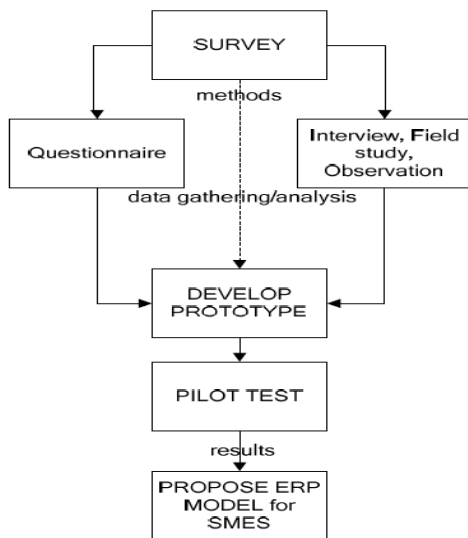


Figure 1: Research Strategy

### 2.2.2 Development Of Low Cost ERP Prototype System For Malaysian Small And Medium Industry (SMI) Using Open Sources Software.

Open source ERP system for specific Malaysian small and medium industries area proposed by [5]. Their study included two objectives as follows:

1. To design an alternative framework and methods in developing open source ERP system for small and medium industries.
2. To develop a prototype open source ERP system that can be implemented in certain small and medium industries sector for their competitiveness improvement.

In order to achieve the aforementioned objectives they had adopted five steps as follows:

- Preliminary phase:

This is the first stage that will be passed by the system developer. This phase focuses on the problem identification and data collection phase.

- Analysis / Definition Phase:

The phase evaluates the organizational baselines that form the foundation for process redesign, the system build and changes in management.

- Design phase:

This phase incorporates the direction-setting information from the preliminary phase and baseline information from the analysis phase to create new designs for a desired future state.

- Construction and Implementation phase :

This phase takes products from the design process to create tangible operational processes and information system support.

- Post Implementation Phase:

This phase consists of system testing, maintenance, initial asses SMI and reporting activities during the research.

### 2.3 Combination Model For An ERP System Development Methodology

Ahituv et al [6] developed a generic model for an ERP system development methodology that combines three structured approaches which are the traditional system development life cycle (SDLC), the prototyping approach and the application software package life cycle. Due to the unique

characteristics of the ERP system, none of these three models could be solely used for implementing an ERP system. For this reason, the ERP life cycle

model is one that combines main features from these models. The ERP life cycle model is described in Figure 2.

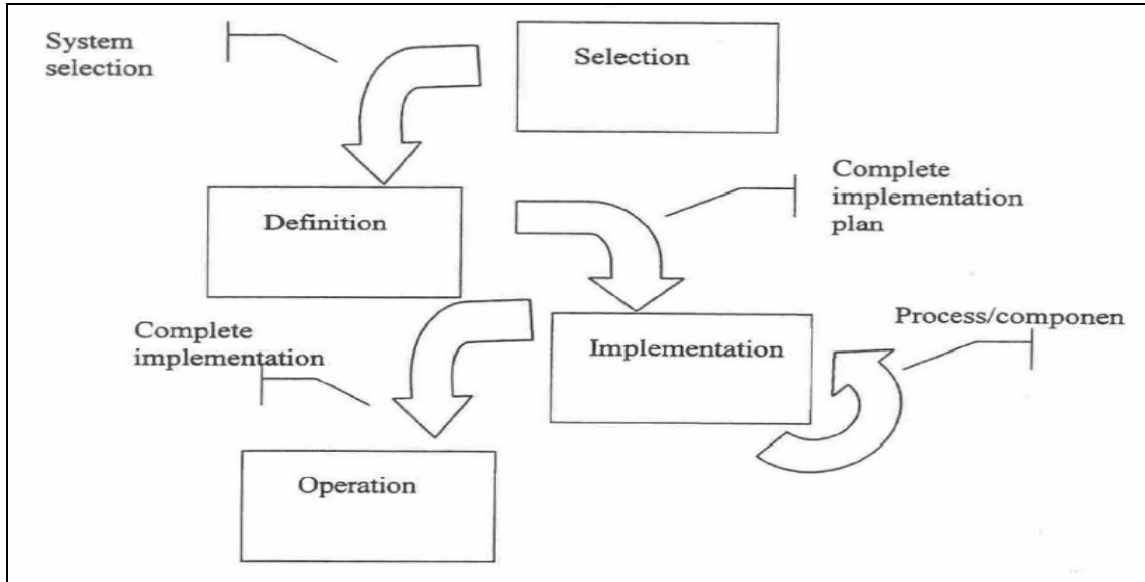


Figure 2: ERP Life Cycle Model

In the selection phase, the regular activities and the exclusive ones of the organization are examined in order to establish the boundaries of the project.

During the definition phase, the definitions of the system components that have to be incorporated are done and the implementation plan is also prepared.

The implementation phase is the essential part of the life cycle model. In this phase, the redesigning of organizational processes is done to be incorporated with the ERP system. The ERP system is implemented in this phase and the user training and acceptance testing are also performed. Ultimately towards the end of this phase, either the system will be changed based on any errors or the project progresses to the operation phase. This phase is repetitive based on the number of component/process of implementations defined in the definition phase.

During the operation phase, the ERP system will be fully functional and will be upgraded, if needed. The following is a breakdown of these four major phases into more detailed steps.

### 3. PROPOSED ERP DEVELOPMENT METHODOLOGY

The proposed ERP methodology component in this study depends on the theory that an enterprise can capitalize on its returns by increasing the use of

its fixed resources supply [5]. The figure 3 illustrates the two main methods that make up the ERP methodology such as preliminary study and ERP system development.

The proposed research methodology constitutes the preliminary study as the first method, based on Shahawai and Idrus [4] however we have done some modifications to conduct the preliminary study of this research.

The preliminary phase collaborates with the problem identification and data collection phase, this phase comprises a current status questionnaire in order to identify the current status and practices of ERP system in SME Malaysian manufacturing. This phase also adopts the readiness assessment questionnaire to identify the scope of this research through the level of readiness for ERP adoption in Malaysian of manufacturing SMEs.

The second phase constitutes the adopted system development method for ERP system based on the ERP system development life cycle based in the literature. In order to understand the existing ERP system development life cycle an in-depth search on various published system development methodologies, system implementation methodologies developed by ERP system vendors have been carried out to accomplish the objective of the proposed ERP system.

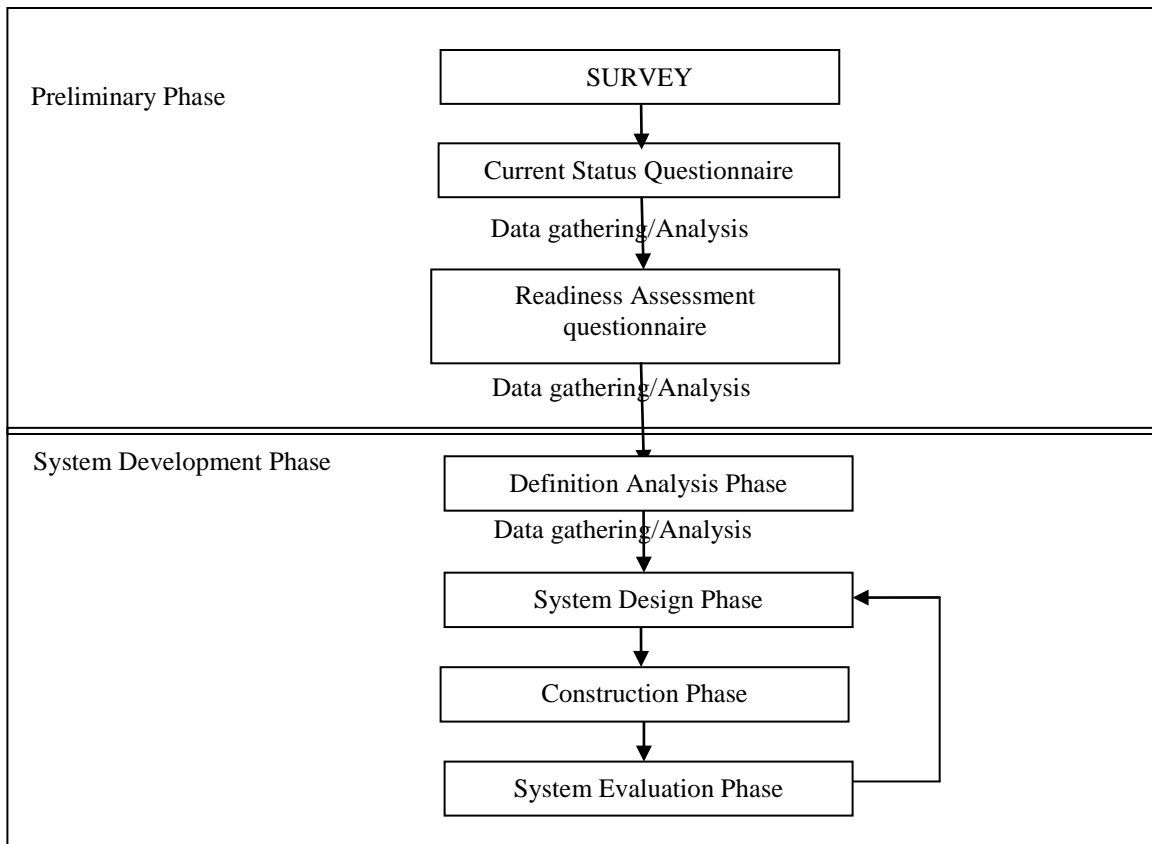


Figure 3: Research Methodology

As mentioned above the proposed system development methodology for ERP system has been extracted from abovementioned sources and fine tuned to fit the Malaysian Small and Medium manufacturing requirements in order to optimally make use of the advantages of the features of the ERP system. The figure 3 illustrates the four phases of the ERP system development methodology such as: analysis and definition, design, construction, and evaluation phases.

The analysis phase is conducted to recognize the functions of ERP that have to be incorporated into the system to achieve the objectives, during this phase a field study research (Documenting) will be conducted to get a better understanding of the business process of the SME Malaysian manufacturing. The design phase has been adopted to integrate direction setting information from the preliminary phase and baseline information from the analysis phase to create new designs for a desired ERP system. The objectives of construction phase are to take products from the design process and to create tangible operational processes and information system support. In the evaluation phase, the evaluation criteria such as usability

testing, compatibility testing and suitability testing are adopted in order to assess the goals of the developed ERP system. The instruments, tools and of desired objectives of each phase of the adopted methodology will be explained in the next sections.

### 3.1 Preliminary Phase

Preliminary research is very essential in order to identify and comprehend a problem. The preliminary study will provide new insights, and directions on a phenomena or field of study [7]. The impact of preliminary or exploratory studies can be totally felt at the situations when there is lack of knowledge on the specific field of research [8]. According to Saunders et al [7] the following are fundamental means of conducting preliminary research: a search of the literature, questionnaire, talking to experts in the subject and conducting focus group interviews

This phase collaborates with the problem identification and data collection phases. As shown in figure 4, two Quantitative researches will be conducted respectively in preliminary phase, the current status questionnaire is conducted to identifying the current status and practices of ERP system in SME Malaysian manufacturing and the

readiness assessment questionnaire is used to determine the scope of the research by rating the level of readiness for ERP adoption in Malaysian of manufacturing SME sectors.

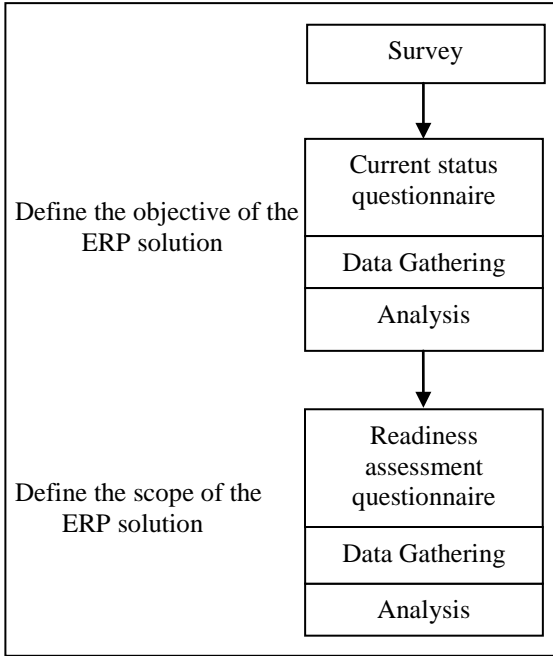


Figure 4: Preliminary Phase

### 3.1.1 Current status questionnaire

Based on the broad study of the present condition in terms of adopting ERP systems in Malaysian SMEs, we have found that there is weakness in the adoption of the ERP package. According to [9] only 10% of the Malaysian SMEs have used ERP, despite the efforts of Malaysian government to motivate the SMEs to use ICT. Based on the above there is a need to conduct a preliminary study to identify the reasons and factors that prevent the Malaysian manufacturing SMEs from fully adopting of ERP system. This will help to avoid those factors while developing ERP modules which in turn will boost the successful ERP system adoption in SMEs of Malaysia Manufacturing

### 3.1.2 Readiness assessment questionnaire

During this phase the readiness of manufacturing SMEs in Malaysia to adopt the ERP system will be measured and investigated by conducting a survey questionnaire. This questionnaire is aimed at determining the Malaysian manufacturing SMEs sectors that are committed and able to adopt the ERP systems. The ERP system will be developed to one of the SME Malaysian manufacturing sectors based on the readiness questionnaire as committed adapters.

## 3.2 System Development Method

This is the key phase of the methodology as it links the functions ERP system with the enterprises business process and takes the designed process to create tangible operational process. The ERP system is acquired as an application software package or it is developed in-house. Hence the ERP life cycle approach depends on the system development methodology.

Oates [10] stated that the developers have the option of choosing published system development methodologies such as MDSS (Microsoft Dynamics Sure Step Methodology) [11], SDLC (System Development Life Cycle), SSM (Soft System Methodology) [12], or they can use their own systems development methodology, possibly unique to their one project, drawing upon modelling techniques and process stages with which the developer is already familiar, such as UML [13]. The most important aspect is to use an appropriate combination of text, diagram, models, mathematics and code segments so that the readers can see how they moved from the initial awareness of problem to increasing understanding, to possible design solution, to implemented computer- based product. Similarly, the final system and report should show traceability: readers should be able to look at the final implemented product and trace back to see how this implementation is related to the design and analysis stages.

We have suggested and described a generic model for an ERP system development method. The definition of the method phases is based on the following sources:

1. Microsoft Dynamics Sure Step Methodology [11].
2. System Development Life Cycle (SDLC)
3. Development of low cost ERP prototype for Malaysian SMEs Using open source software [5].
4. A system development methodology for ERP system [6].

The proposed ERP system development method has the combined features from abovementioned methodologies and the ERP system is built based on two criteria:

1. Achieve the desired objectives of the developed ERP system as follows:
  - Develop the necessary ERP functions to avoid the complexity and difficulty in implementation and using the system.



- Cover and fit the enterprises business processes and handle business-specific matters.
- Develop ERP system compatible with the business functions of the enterprises.
- Save both of time and cost of the implementation process.

2. The characteristics that affect the ERP life cycle within SMEs area. There are nine main characteristics that shape the ERP life cycle within SMEs sectors as follows: system complexity, system's strategic importance, system's flexibility, application scope, technological infrastructure, business process, type of organization, employing consultants and user involvement.

Phases objective Development Phases

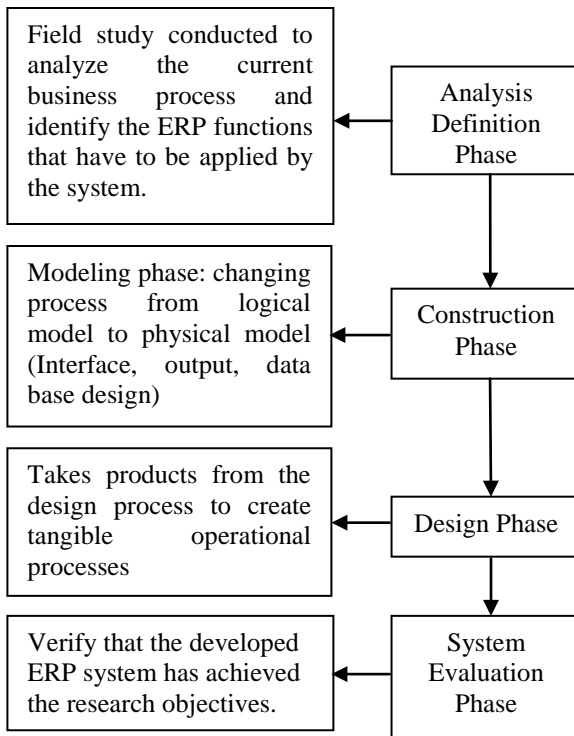


Figure 5: System development Phase

The figure 5 illustrates the four phases of the proposed system development methodology for ERP system as follows: Analysis and Definition phase, System Design phase, Construction phase, and system evaluation phase. Each phase will clarify its objectives and the instruments and tools used to achieve the objectives of the research. The four phases are elucidated in the following sections.

The following is a breakdown of these four major phases into more detailed steps.

### 3.2.1 Analysis and Definition Phase

This phase evaluates the organizational baselines that form the establishment for process redesign; this phase generates the ERP functions that have to be incorporated to the system, Figure 6 illustrates the steps of analysis conducted during definition and analysis phase to obtain the compatible ERP functions for the Malaysian Small and Medium manufacturing that can be easily adopted to achieve the desired objectives of ERP solutions. The four steps of the definition and business process analysis phases are: Documents Field work, current business process analysis, future business process analysis and Unified Modelling Language (UML) approach. The following is the analysis and definition phase into more details for each analysis step.

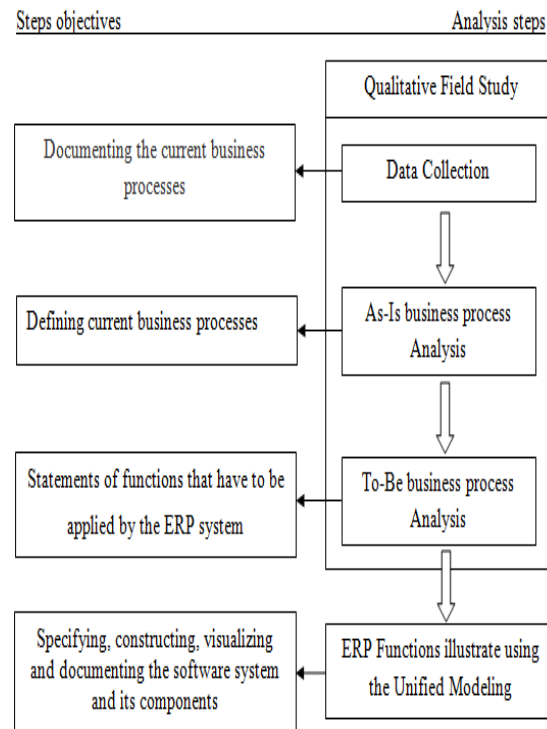


Figure 6: Definition and Business Process Analysis Phase

#### 3.2.1.1 Documenting business process

Basically enterprises should spend lot of time for documenting or over-analyzing the current processes. Organizations should at least develop details of level 1 of their current processes [14]. Documents can be considered as another source of business process of organizations, an alternative to interviews and observations and questionnaires. Documents are divided into two types: identified



documents and researcher-generated documents [10].

- Identified documents already exist prior, such as the documents found in organizations: production schedules, job description, process flow, and so on.
- Researcher-generated documents are created solely for the purpose of the specific research task, and would not otherwise have existed. For example, a researcher undertaking ethnography would probably take photographs and make field notes about what he has observed and thought.

Documenting is the best means of conducting qualitative field studies in order to learn about structure of organizations [10], the documents are also useful in redesigning a product. [10, 14-15] the identified documents are recommended to determine and analyze the business processes.

Based on previous work we have identified that field work is the best method to investigate the business process by collecting the documents that explain the existing process flow for the selected enterprises and determine the software components of the ERP system that can interact with the enterprises business process. The outputs for this phase are the ERP functions that will be applied by the system to achieve the research objectives.

### 3.2.1.1.1 Analyzing Business Process Documents.

One of the most arguable issues in the world of ERP and IT is the amount of attention to be given to as-is and to-be business processes. Some ERP developers' feel that enterprises should let their ERP systems decide the new processes, while others feel that as-is and to-be processes should be documented and analyzed in detail prior to choosing ERP software component. According to [14] the documenting and analyzing of as-is and to-be process approaches are recommended because it works on the basis of matching the current business process with the ERP system functions and redesign the current business process that cannot match with the ERP functions. Hence we have adopted this approach to avoid the high cost of redesigning the current business process.

During this phase the Functional and technical requirements will be reviewed to determine the system development needs. The collected business process documents will be analyzed in two steps such as: as-is business process analysis and to-be business process analysis.

### Step1: As-Is business process Analysis

During ERP implementation, understanding the defective process is very important before a business process can be re-engineered. Hence it is important to first carry out a critical and objective business process definition and analysis before the system design. However, restructuring a business process and adherence to best practices are very important[16].

In as-is business process analysis is carried out to observe the process flow of selected enterprises' related with ERP, according to [14] a decent amount of attention for defining current business processes is necessary. The benefits of doing so are as follows:

- It helps to get the alignment and understanding of various business units and aspects of current operations. Nevertheless many managers and key stakeholders do not have a clear view of the functionalities of other parts of the organization. The documenting as-is business processes helps to get a clear picture about all the aspects of the current business processes.
- It helps to determine the current work of employees, and to identify the gaps between the current and future states.
- It helps to determine the key operational pain points.

During this phase the current business process is divided into two parts as shown in figure 7, the first part is the business processes that are different from other enterprises, and the second part is the common business process within the enterprises in the same sector.

### Step 2: To-Be business process analysis

This step is very important as well. In order to develop the appropriate business requirements and to select the software components of the ERP system that is most effective for business and how these components interact with each other, during this step we can understand about the future business processes. The key benefits of this step are:

- It helps to define the future operational model and business processes independent of the ERP software. This enables having creative thinking and getting opportunities to succeed with the help of IT and enable measurable business improvements.



- In conjunction with the as-is processes, it helps to identify the gaps between the current and future jobs, roles, and responsibilities.

- It helps to define key performance indicators to drive the business improvements and accountability. New responsibilities and opportunities will be generated by the new processes hence we need performance measures to enable this.

- It helps to prioritize the needs of customization, configuration, integration, and report-writing after the software component is selected. It will be very difficult to determine the appropriateness of the customization, configuration and additional development without understanding where we want our organization to go from an operational perspective.

Implementing an ERP system does not necessarily mean redefining an organization's business processes. The ERP System can be used to enhance and optimize the existing business process; however, a complete re-engineering might be precisely required in some cases when the current business process does not match with ERP functions [16].

The current business process will be integrated and designed based on two criteria:-

- Matched business process: Business processes that are matched with the ERP functions are integrated and designed without modification.
- Unmatched business process: Are processes that do not match with the functions of the ERP system and these processes are improved and redesigned for to-be system.

This study will design the ERP system for manufacturing of SMEs in Malaysia using the customization and configuration technique as follows:

1. Customization technique is also known as a standardized business processes and it is used to design business processes that are similar and common to all enterprises within manufacturing of SMEs in Malaysia
2. Configuration technique is used to design the ERP functions related to business processes and structure that differ among enterprises and cannot be standardized between the enterprises within the

same sector, however the configuration allows each enterprise to build their own structure and functions that differs from other enterprises.

The core outputs for this phase are the statements of functions that would be integrated to the system to achieve the projected objectives.

### 3.2.1.1.2 Unified Modelling Language (UML) approach.

Using the Unified Modelling Language (UML) approach the identified ERP system functions based on the previous steps are illustrated. The UML is a language for specifying, constructing, visualizing and documenting the software system and its components [5]. The UML will be helpful to identify, design, develop and document the aspects in software. It also has been proven as a language that can model an ERP system successfully by producing normal and simple design. Moreover Park and Lee [17] refer that the UML can present engineering activities and combine the concepts in Booch, the Object Oriented Technique (OMT) and the Object Oriented Software Engineering (OOSE). The UML diagrams represent complete understanding of the ERP functions. It enables a simplified representation of the system activities such as the functional aspects of specific models.

Three categories of UML diagrams of the proposed ERP system are:

- Structure Diagrams include the Class Diagram.
- Behaviour Diagrams include the Use Case Diagram
- Interaction Diagrams (derived from the more general Behaviour Diagram) including the Sequence Diagram.

### 3.2.2 System design Phase

This phase integrates the direction-setting information from the preliminary phase and baseline information from the analysis phase to generate new designs for a desired future state. The improvement design of the business processes depend the Business Process Re-engineering approach. The system design phase is considered as the modelling phase. It constitutes the logical model changing process to physical model. Whereas, the physical model consists of the user interfaces, output and database design. The class diagram will be presented in this phase. The database built will have many tables for each class involved in the system such as: supplier, agent, product, item, incoming stock, outgoing stock, Bill of Material (BOM), Staff, customers and password



table. Both of customization and configuration will be used to design system functions.

### 3.2.3 Construction Phase

This phase converts the program codes into real products. In this phase, the proposed ERP system with a database will be constructed and the program source code will be written. Centre for Technology in Government, University at Albany (1998) made a survey on Systems Development Process Models and has defined the coding process as programming steps that involves the creation of the system software. Requirements and systems specifications from the system design step are translated into machine readable computer code. This is the most vital phase in the implementation of the ERP system. The success in this phase is the backbone of the project. In this study, the prototype of the ERP system for Malaysian Small and Medium manufacturing will be developed using Java Server Pages (JSP), and MySQL to create the system Database.

According to [18] the Java Server Pages (JSP) has been adopted by many ERP software vendors, now a day's is not considered as language instead, it is treated as a platform. Meticulous evolution of Java had made it as a leading software platform. The ERP vendors are not an exception of using Java. Some of them have migrated from other platforms towards java, while few others are attempting to do so. The features of JSP are more valuable compared with other software platforms.

### 3.2.4 Evaluation Phase

The ERP system is evaluated based on the following criteria: Functionality, completeness, accuracy, performance, reliability, usability, accessibility, aesthetics, and entertainment, fit with organization, and so on. The use of these evaluating criteria depends on the reason of development of the prototype and is related to the original research objectives [10].

The desired objectives of the developed ERP system are:

- To develop the necessary ERP functions to avoid the complexities and intricacies during implementation and using the system.
- To cover and fit the enterprises business processes that handles business-specific matters.
- To develop ERP system compatible with the business functions of the enterprises.
- To save both time and cost of the implementation process.

During this phase three criteria of the evaluation will be adopted to evaluate the desired goals of the developed ERP system.

## 4. CONCLUSION

This paper, has proposed a methodology for the successful implementation of ERP in Malaysian of manufacturing SMEs. Multi methodology approach was adopted in this study. The preliminary phase was the first method that has been conducted to identify the problem and objectives of the research, this phase consisted a two quantitative questionnaires, the current status questionnaire was conducted to identify the current status and practices of ERP system in SME Malaysian manufacturing and the readiness assessment questionnaire was adopted to identify the scope of this research by rating the level of readiness for ERP adoption in Malaysian of manufacturing SMEs.

The second phase constitutes the system development method for ERP system based on ERP system development life cycle derived from the literature study on various published system development methodologies. The four phases of the ERP system development methodology are: analysis and definition, design, construction, and evaluation phase. The analysis phase will be conducted to identify the ERP functions that have to be applied by the system to achieve the declared objectives, during this phase the qualitative field study research will be (Documenting) conducted to get the better understanding of the operation business process by small and medium manufacturing in Malaysia, the design phase is adopted to incorporate direction setting information from the preliminary phase and baseline information from the analysis phase to create new designs for a desired ERP system. The objectives of the construction phase are to take the products from the design process to create tangible operational processes and information system support. In the evaluation phase, three evaluation criteria are adopted to evaluate the desired goals of the developed ERP system and each criterion was measured with one of the objectives as follow: Usability Testing, Compatible Testing, and Fit with organization Testing.

In terms of future research, we suggest an ERP model which can be adapted to the requirement of manufacturing SMEs in Malaysia. This model or prototype can be evaluated and tested to several selected manufacturing SMEs around Malaysia.

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