

Novel Integrated Framework for ERP Selection and Implementation

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ABSTRACT

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As the economic pressure on businesses increases, organizations try to adopt innovative technology solutions to cope with this pressure and adapt to the rapid market changes. Particularly for small and medium enterprises (SMEs). They must integrate all resources and information levels to highly utilize their limited resources and survive the local and global competition. This could be achieved by adopting the best suitable Enterprise Resource Planning (ERP) system. On the other hand, properly selecting and implementing the right ERP system is challenging for many reasons. Hence, this paper provides a novel integrated framework for establishing and implementing ERP systems for SMEs. It is a four-phase theoretical framework that is verified through a case study in a manufacturing plant. The phases start with top-level managers' commitment, problem identification, and documenting expectations. Then, the overall system scanning, and data gathering is made for the next step of system selection. And finally, the implementation phase. The framework is agile for using qualitative or quantitative tools based on the company's nature, size, and requirements.

1. INTRODUCTION

Competition in the modern world is not limited but rather worldwide; therefore, businesses are obligated to lower total costs, increase investment return, shorten lead times, and improve consumer demand response in order to survive this competition. Moreover, enterprises are facing challenges in operating dynamics and complexity, which could not be optimally managed using manual/traditional information systems. As a result, there is an emerging need to use Enterprise Resource Planning (ERP) systems for better management. An ERP system is an integrated computerized system that automates the flow of materials, information, and financial resources among all business departments using a single database [1]. Organizations utilize the ERP system to manage their day-to-day operations [2]. ERP system is crucial as it connects multiple business processes besides allowing data to flow across them smoothly.

Having a suitable ERP system with proper implementation can have various advantages, starting with the most fundamental ones like improved company management and information flow. As a result, it is possible to improve economic indicators, which eventually results in an increase in firm profitability [3]. Consequently, it would enhance operational excellence, supply-demand match, lead time as well as customer satisfaction. In addition to this, ERP systems accommodate all kinds of business activities with the goal of increasing productivity [4]. Hoch and Dulebohn also claim that ERP systems can be utilized to integrate information flow between stakeholders as well as between the organization's major functional areas (Finance, HR, Manufacturing, Customer Relationship Management, Supply Chain Management, etc.) [5]. It could be obtained that an ERP

system is the best choice for an enterprise when: (1) The current system used limits the company's market expansion and global growth capabilities. (2) Enterprise manager needs to monitor fragmented software such as accounting and warehouse management system (WMS) concurrently. (3) Need to avoid stockouts and product damage and enhance order fulfillment concurrently. (4) Need to monitor/answer daily business inquiries such as the revenues and sales associated with a specific product. (5) Manually processing too much data when information cannot flow among departments, reporting takes longer, errors often occur, and decision-making is hindered. (6) Catching new opportunities is so hard because it is easier to identify and leverage new profitable business opportunities using the ERP system [6].

Accordingly, it might be said that the ERP system is a critical asset and a very important success factor for any company with all sizes and capabilities, especially small and medium enterprises (SMEs). However, it is very challenging to select the proper system and implement it correctly. The most common challenges companies usually face while selecting or implementing ERP systems are [7, 8]: (1) Properly identifying system requirements and expected goals. (2) Inadequate selection of a suitable vendor compatible with company resources, infrastructure, or budget. (3) Skills and knowledge level of the staff. (4) Commitment of top management. (5) Poor communication system and managerial conditions. (6) Fragmented authorities and capabilities. (7) Over-processing, complex architecture, and unused modules. (8) Insufficient IT stability. These challenges are a speedbump for the ERP system benefits. Furthermore, choosing the incorrect ERP software could lead to the project failing or damaging the system, which could have a negative effect on overall business performance [9, 10]. Hence, researchers

proposed different methods for ERP selection alongside some implementation tips [11-15]. One of the methods created a theoretical framework with three phases: define, evaluate, and select. The strategy used aids both manufacturing and service organizations looking to install ERP systems by identifying the best ERP system essential to enhance effective implementation, minimizing the risk of an unsuitable ERP system and resulting project failures [11]. Nonetheless, this framework was a pure qualitative evaluation of different alternatives with rational prioritization. Also, there is a common scoring system that adds quantitative analysis to the selection process [12]. However, it does not guarantee resource viability [13, 14]. In order to reach a decision on the proper ERP system, Teltumbde [15] created a framework based on the Nominal Group Technique (NGT) and the analytic hierarchy process (AHP) and proposed 10 criteria for assessing ERP initiatives. Other methods have been developed based on the mindset of the mentioned frameworks for selection. Regarding implementation, most researchers focus on deploying data in the system and launching the selected ERP system. Nevertheless, there is a gap in the organization's preparation for choosing an ERP system, implementation of detailed processes, and technical follow-up afterward. Through reviewing different guidelines and frameworks made, it was observed that they are not overcoming the common challenges. Furthermore, the implementation frameworks and tips given by researchers are stand-alone frameworks that are not incorporated with the other business factors or the previous step of selecting and purchasing a suitable system. For example, the model by Kalinga and Premaratne provides an integrated implementation framework that focuses on enhancing an up-and-running ERP system [16].

According to the literature, there is no integrated framework that supports the process of having an ERP system from the start till the end of all processes in a company. Thus, this research aims to provide an integrated framework for company preparation, selection, and implementation of an ERP system. This framework is a conceptual framework that is defined as a collection of interconnected concepts, when taken collectively, give a full explanation of a phenomenon or set of phenomena [17]. This framework is designed, validated and verified through case study application in heat ventilation & air conditioning (HVAC) manufacturing plant. The rest of this work is organized as follows: the methodology section includes the work phases, starts with the proposed framework, followed by the case study details, including the company background and implemented phases of the framework. Finally, the study findings and recommendations are given.

2. METHODOLOGY

The research methodology of this research is illustrated in Figure 1. The methodology is divided into two main stages. Stage one is responsible for designing the conceptual integrated framework and identifying the criteria of the company that can use this framework. The second stage is responsible for validating and verifying the proposed framework through case study and experts' feedbacks during implementation.

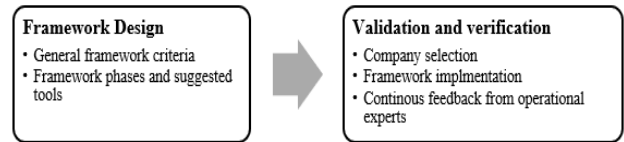


Figure 1. Research methodology

2.1 Framework

The ultimate goal of this framework is to select the proper ERP software which is compatible with enterprise competitive priorities and capabilities besides supporting the implementation process of the ERP system in the company base on the product/service nature and company size. The Framework Phases and steps serve all categories of manufacturing and service industries, regardless of the product variety (soft or hard), plant capacity, type of manufacturing system infrastructure (automated, manual, advanced or Semi-automated), and the enterprise size (small, medium, or large). However, it is more effective for SMEs due to its size and limited resources.

Figure 2 displays the framework phases and steps expected to be taken in each phase. Phase 1 aims to ensure the system - company- readiness for purchasing and implementing an ERP system. This phase starts by top-level commitment as allocating a budget and time for system purchase and implementation, followed by problem identification that allows the company owner/manager/chief executive officer (CEO) to be aware of the core problem that is expected to be solved using ERP system such as longtime of inventory data retrieval, and then the top-level managers put expected set of inputs and output for the ERP system. Phase 2 is responsible for the documentation and data gathering of the current system that will be migrated to the new computerized ERP system. Afterward, phase 3 is responsible for ERP software selection using any of the methods mentioned before -either qualitative or quantitative or a mix between them-. Finally, phase 4 is mainly for the deployment including training of operators. The training of operators is responsible for put all system users on the same base of knowledge and experience to deal with the corresponding functions regardless their education or previous knowledge. Then, testing, iterations, and final launch of the ERP system in the company. There would be also continuous improvement plan for the system based on that suits company growth, polices, and resources.

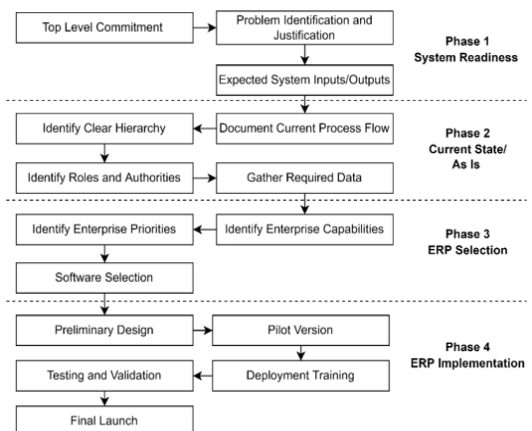


Figure 2. Proposed framework

2.2 Validation and verification (Case Study)

The validation and verification steps are done by implementing this framework in a manufacturing company for heat ventilation & air conditioning (HVAC), mechanical, electrical & plumbing (MEP), and construction fields. The company is a local medium-sized company. It offers individual products and solutions for projects, starting from concept and pre-design. They also provide after-sales services, maintenance, and on-site training, as well as distributing several spare parts locally. The company is operating with semi-automated manner. Base on the criteria mentioned before, this company is considered as a generalized case suitable for validation and verification of the framework. The next section will address the results and discussion for the findings of the framework implementation.

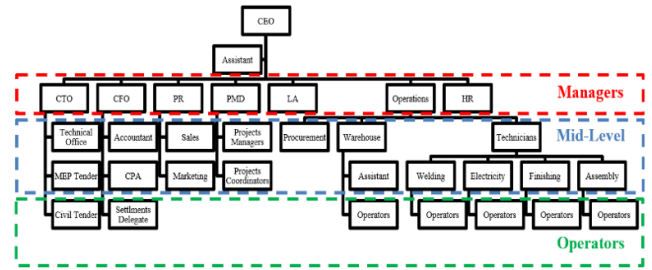


Figure 3. Current process flow

3. IMPLEMENTATION AND RESULTS

3.1 Phase 1: System readiness

The first step in the implementation after picking the enterprise was the first step in the framework itself. To verify the applicability of phase 1, several interviews were conducted with the company CEO and project manager, who are responsible for the whole project of purchasing a computerized ERP system. Then the problem of the company was identified using root-cause analysis. Observing different departments in the company for one week in all its shifts, besides interviewing the manager, revealed that the issues are related to the hierarchy, project management, inventory management, and coordination among departments. These issues obstructed the roles, responsibilities, authority, project flow planning, product tracking, and procurement processes. Accordingly, the expected output has been identified as (1) Enhanced process & information flow. (2) Automated alert when reaching safety stock level. (3) Better Inventory Management. This will be accomplished through the upcoming phases.

3.2 Phase 2: Current state/As is

This phase starts by observing the current process flow in the plant. The process is illustrated in Figure 3. This step is crucial as it gives room for improving process flow before the start, identifying system requirements, and designing the modules and interactions of the ERP system in the upcoming phase. Then a clear hierarchy was built for a clear structure, job descriptions, and authority allocation afterwards, as shown in Figure 4 and Table 1, respectively. In Table 1, the numbers indicate worker level as 1 is the CEO, 2 is for managers, 3 for mid-level workers, 4 for assistant/s, and 5 for operators. Finally, the organization's quantitative data has been gathered to prepare system inputs. The data gathered were products' trees, plant capacities, and reorder points (ROP). Data was collected to serve the identified system requirements settled with the company manager. The requirements mainly revolved around: (1) Improving daily business processes. (2) Smoothing communication. (3) Managing the warehouse and safety stocks. (4) Prioritizing orders based on due dates to avoid back-orders and large compensations. (5) Relieving the overload over the workforce due to an increase in contracts.

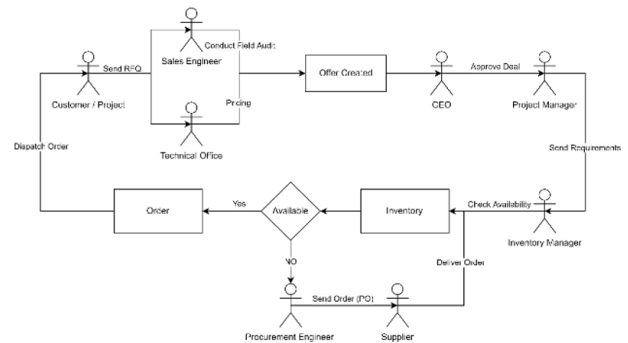


Figure 4. Company hierarchy

Table 1. Authorization matrix

	1	2	3	4	5
Edit all modules	☑				
View all modules	☑			☑	
Extract all reports without permission	☑				
Extract all reports with permission				☑	
Edit daily data related to his/her department without permission		☑			
Edit daily data related to his/her department with permission			☑	☑	☑
View daily data related to his/her department		☑	☑		☑
Extract reports related to his/her department without permission			☑		
Extract all reports related to his/her department with permission					☑

3.3 Phase 3: ERP selection

The suitable ERP software has been selected using the qualitative evaluation for the available alternatives concurrently with company's capabilities and infrastructure. The criteria for evaluating the relevance of available platforms are identified as (1) Business needs, (2) financial capabilities, and (3) applicability of implementation in terms of User Experience (UX) and User Interface (UI). Afterward, the most suitable platform was selected based on the evaluation criteria, as shown in Table 2. Odoo platform has been selected because it is accessible as an on-premise solution as well as a ready-to-use Software as Service (SaaS) solution, which allows the company to break down implementation costs concurrently with software deployment plans and training.

Table 2. Qualitative selection

	Company Size		Technology and Infrastructure	
	Small & Medium	Large	On-Premises	Cloud-Based
1	Cash Management		Sheets, Odoo	
	Inventory Management		MRP Sheets, Odoo	
	Production Scheduling	Sheets, Odoo	Sheets, Odoo	SAP, NetSuite, Microsoft
	Sales Management		Sheets, Odoo	Dynamics, Odoo
	Departments Integration		SAP, NetSuite, Microsoft	
2	Variety of Reports		--	
	System Security			
	Free Demo	Odoo	MS Excel, Odoo	Odoo
3	Low annual subscription		MS Excel, Odoo	
	Ease-of-Use		MS Excel	Microsoft
	Ease-of Maintenance		MS Excel	Dynamics, Odoo

3.4 Phase 4: ERP implementation

In this phase, the preliminary design for system functions and expected interactions have been made using the use case diagram. Figure 5 illustrates the use case diagram for the ERP system that will help developers while implementing it on the Odoo platform. In the use case diagram, the different actors that will be interacting with the system are abstractly assigned to specific functions that will be done using the system. Table 3 shows the actors’ description and their responsibility to be assigned to the system based on the authorization matrix. Moreover, Table 4 explains some of the use cases to avoid misleading terms and have a clear definition for all levels of workers in the company.

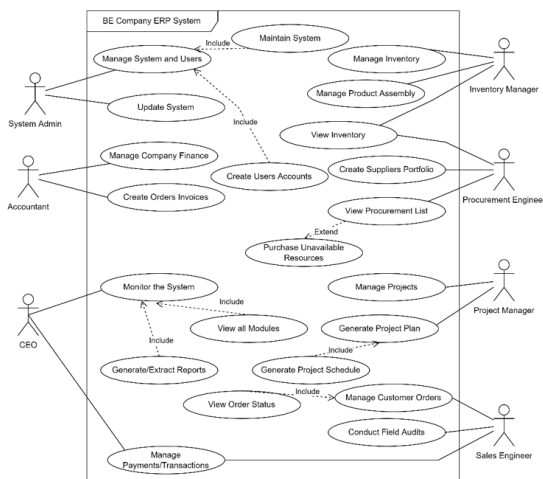


Figure 5. Use case diagram

Afterward, the pilot version of the ERP system has been implemented on Odoo by the authors starting by adding company profile, workers’ profiles and authorities, products tree and corresponding ROP, calendar and important dates, suppliers’ details, and finally, the system features have been tested as shown in Figure 6 which the test of requesting a quotation in the system. Also, Figure 7 shows one of the most important features, which is the safety stock alert. Then, there was a deployment training to train all system users on their duties in the system to assure smoothness of use before the final launch. During the training there was a testing for the feature and some edits made in accordance with functionality and ease of use. Also, the operators made a standardized operating procedures document that will help future users to get familiar with system easier later.

Table 3. Business actors glossary

Actor	Description
System Admin	Responsible for technical aspects of the system, including maintenance, upgrade, creating accounts, and giving authorities
CEO	The Chief executive officer manages the whole organization, creates the global key performance indicators (KPIs), and takes decisions accordingly
Project Manager	Responsible for projects' planning, scheduling, monitoring, and closure with clients
Inventory Manager	Responsible for overseeing the inventory levels and matching the availability with demand
Accountant	Responsible for managing the company's finance and assisting in making financial decisions
Procurement Engineer	Responsible for managing and executing purchasing and sourcing activities
Sales Engineer	Responsible for enhancing sales, repetition, and customer satisfaction

Table 4. Use cases glossary

Use-Case Name	Use-Case Description	Actors (roles)
Manage System and Users	This use case describes the action of creating company profiles and workers' profiles with suitable accessibility and user credentials	System Admin
Generate/Extract Reports	This use case describes the event of generating periodical and insightful reports. This could be done by others through the CEO	CEO
Manage Product Assembly	This use case describes the action of monitoring the use of inventory with the expected throughput of assembled products to avoid wasted or undocumented resources	Inventory Manager

To sum up, in the implementation section, a complete tour of the modules of Odoo has been performed, showing the different phases the company will go through to establish its ERP system. It begins with creating company profiles as well as users’ profiles. Then start setting the inventory level according to the number of products on hand. Followed by filling the BOMs for the products that need to be assembled and be ready to accept orders and projects. Furthermore, the

framework has been verified as the process was smooth and insightful, and the implementation had no errors. The implementation of the framework and ERP system led to a set of improvements for the system as follows: (1) Increased operating efficiency and service level. (2) decreased normal times taken for administrative work by more than 50%. (3) No crossed rules and clear sustainable organizational structure. (4) Adopt standardized and scalable operating procedures. (5) Acquire an insightful dashboard for daily performance follow-up. And finally, (6) Having a safety stock alert that makes them capable of restocking and have almost zero backorders.

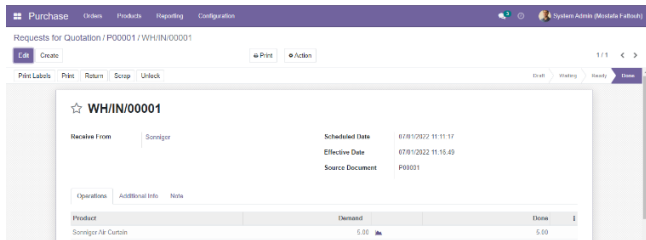


Figure 6. Requesting a quotation

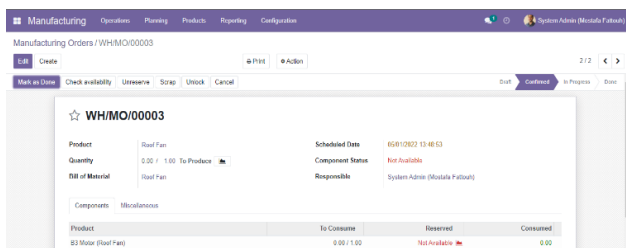


Figure 7. Safety stock alert

Although the fruitful results of the framework implementation, there should be a continuous improvement plan and feedback for the system. As the company grows, it develops new system requirements that would be taken into consideration or be adopted by the ERP system. Besides, the periodical feedback from different system users should be communicated to top management for proactive behavior that will support the success of ERP system in the enterprise.

4. CONCLUSION

Due to the fact that many SMEs have limited knowledge of ERP systems, it is crucial for SMEs to implement them in order to conduct business successfully in the current competitive environment. The literature suggested that there is a need for a framework that supports choosing the best ERP system and implementing it properly, particularly for SMEs. As a result, a theoretical framework with four phases: System readiness, Current state, ERP selection, and ERP implementation—that SMEs can utilize was developed in this study. A case study was used to validate and verify the framework. The result of this was not only verifying that the framework is successful and efficient for SMEs, but it also rapidly enhanced the company’s performance in a short time. Through implementing the four phases of the framework including system preparation, selection and implementation, currently, the company’s management can track the movement of products in and out of inventory, monitor projects, and have alerts against stockouts. Thus, the company is able now to expand its business and operations according to its plan

without fearing hazards to its management capabilities. Additionally, for better performance, there are some operating tips obtained during the implementation. It is recommended to have a quartile meeting including main users to discuss the improvement plan for upcoming month based on the growth. In addition to this, there would be a chat or a channel for immediate operators’ feedback that will allow the team especially IT team to take more effective and faster corrective actions towards the system. Finally -in future work- it is planned to apply this framework to the different manufacturing plants and service providers for better results.

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NOMENCLATURE

SMEs	Small and Medium Enterprises
ERP	Enterprise Resource Planning
WMS	Warehouse Management System
NGT	Nominal Group Technique
AHP	Analytics Hierarchy Process
HVAC	Heat Ventilation & Air Conditioning
MEP	Mechanical, Electrical & Plumbing
ROP	Reorder Point
CEO	Chief Executive Officer
CTO	Chief Technical Officer
CFO	Chief Financial Officer
PR	Public Relations
PMD	Project Management Department
LA	Legal Affairs
HR	Human Resources
CPA	Certified Public Accountant
UX	User Experience
UI	User Interface
BOM	Bill of Materials
RFQ	Request for Quotation
PO	Purchase Order