

The Evaluation of Enterprise Resource Planning (ERP) Implementation, on the Performance Improvement of Business Processes

Case Study: In One of the Construction & Infrastructure Companies in Indonesia

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Abstract:- In this development era, many infrastructure projects are being held all over the world, that requires company in the industry to improve their performances. Furthermore, in an effort to increase performances and finally create efficiency, The Indonesian Government issues policy that directs the infrastructure companies especially State-Owned Enterprise's (SOE's) to implement Enterprise Resource Planning (ERP). The purpose of this research is to evaluate the results of ERP implementation towards the business process performances improvement in one of the constructions & infrastructure SOE which has a crucial role in the establishment of the Trans Sumatera Toll Road Megaproject in Indonesia. Analysis of business process before and after implementation is carried out as well as the survey to evaluate the performances of expenditure management business process in the company after the ERP implementation. The evaluation criteria are developed based on the four dimensions of business process performance, which is time, cost, quality and flexibility. The results from the study indicate that ERP Implementation has given positive effect toward business process performance improvement, while there are still some weak points in the implementation. Due to this research, opportunities for improvement are identified to support company in making decision for better ERP implementation.

Keywords:- Enterprise Resource Planning, Business Process Improvement, Business Process Performances, State Owned Enterprise, Operations Management.

I. INTRODUCTION

Enterprise Resource Planning (ERP) systems have been considered as essential for gaining and maintaining competitive advantage in the globalized market under ever increasing competition [14]. It is an integrated information system that is used to support business processes and resource management within an organization and bring transparency in the system [9, 11, 26]. According, to Dumas [7] ERP is one of the most utilized tools in Improving the Business Process in an organizations. By Improving business processes, companies can stay competitive and improve customer responsiveness, employee productivity in their

work, and the Return on Investment (ROI) of the company [10]. ERP systems are widely used across various sectors and industries such as manufacturing, retail, healthcare, financial service, oil and gas, construction and many more. There are varieties of benefits that researchers have shown through ERP implementation such as improved efficiency, better communication and coordination, improved decision making, better customer service and retention, increase financials, better management of assets, easiness in growth & expansion with improve flexibility, accurate and speedy transactions, decline in cycle time and head counts, fewer resources and increased revenue [17, 22]. However, it has been found that the success rate of ERP implementation is low in the construction industry as compared to other industries even after investing huge amount and time for its implementation [9]. It is caused by several obstacles like the complexity of the system, high cost, lack of training, and many more [3, 9]. However, systematic implementation of ERP system added benefits to infrastructure construction enterprises in various divisions i.e. integration of all business processes, fully computerized generation of reports to assist in decision making, and attainment of competitive advantage [6].

According to China Research & Intelligence (2023) analysis, with the development of Southeast Asia's economy, the infrastructure construction and real estate sectors continue to grow, contributing to the growth of the construction industry. In Southeast Asia, the construction industry has made a significant contribution to the Gross Domestic Product (GDP) [24]. In 2022, The GDP in Southeast Asia is approximately 3,658 billion USD, with the largest contribution to current prices coming from Indonesia, amounting to 1,319 billion USD [12]. According to data from BPS (Central Statistics Agency in Indonesia) regarding the structure of Indonesia's GDP based on economic sectors in 2022, the construction sector contributed 9,77% to the total GDP of Indonesia. It is directly influenced by government policy because the government can regulate the economy by constructing public works during a period of stagnation [8]. Competition in construction services requires the companies to be efficient because it affects the performance of companies in the sector [24]. To support the business performances and prepare construction firms in Indonesia for delivering the best of their abilities, the

government through the Ministry of SOE directs the industry to carry out digital transformation by implementing ERP. However, the implementation of ERP in the construction industry in Indonesia has only been carried out over the past decade.

To assess the level of success of ERP implementation in a company, process performance evaluation is necessary. Many researchers conducted the evaluation using the four dimensions of process performances ; time, cost, quality and flexibility [7, 13, 20]. Evaluating the performance of ERP implementation in a construction company is also important given the challenges faced, especially in the context of rapid infrastructure development occurring all over the world [2, 19]. Therefore, the aim of this study is to measure the improvement in business process performance resulting from the implementation of ERP in the construction & infrastructure company. This research will utilize business process analysis methods to compare the performance of business processes before and after ERP implementation. It will involve collecting primary data through interviews, surveys, and observations, as well as utilizing secondary data. The research is based on a case study conducted in one of a state-owned construction enterprises in Indonesia that specializes in infrastructure development and plays a significant role in the construction and development of various infrastructure projects throughout Indonesia.

This paper consists of five sections. The first section discusses the background of the research, the second section contains a literature review related to the research topic, the third section presents the research methodology, the fourth section presents the research findings and followed by a discussion of the findings of the data processing, and the final section contains the conclusion and summary of the conducted research.

II. LITERATURE REVIEW

A. *Process Improvement with ERP Implementation*

Technology in general and especially Information Technology (IT), is a key instrument to improve business process [7]. One of the IT initiatives to improve business process is by implementing ERP which is aimed to integrate the business process of a company and help organizations obtain a competitive advantage [4, 25]. The direct benefits of this integration include operational simplification and expedited decision-making processes [2]. Furthermore, the main purpose of business process improvement (BPI) is, thus, considered to make business process – interrelated activities, procedures, and behaviors efficient, effective, and flexible [5]. BPI as a stage in BPM lifecycle, is an approach to increase the effectiveness and efficiency of business processes that produce output for external and internal customers [10]. This means that IT including Enterprise Resource Planning (ERP) can be used to optimize the execution of business process [7]. The ERP system also provides various services that serve as tools for monitoring all financial accounting transactions in real-time [26]. It provides a solution to the challenges encountered in project

tracking, resource management, and decision-making within project-based organizations in the construction industry [6]. However, Implementing ERP in a company is a complex, lengthy, and costly process, often worth millions of dollars. In many cases, ERP implementation also requires business process reengineering to be undertaken [21].

B. *Business Process Analysis*

Business process analysis involves gaining an understanding of issues concerning the current operation of a business process, which is also a term used with a rather broad meaning including a range of different tactics such as simulation and diagnosis, verification, and performance analysis of business processes [18, 28]. The aim of business process analysis is to investigate properties of business processes that are neither obvious nor trivial [27]. According to Dumas [7] in a Business Process Management (BPM) lifecycle, process analysis is a phase in which issues associated with the as-is process are identified, documented, and whenever possible quantified using performance measures. The output of this phase is a structured collection of issues. These issues are prioritized based on their potential impact and the estimated effort required to resolve them. BPM itself is defined as continuous and permanent commitment translates into a life cycle model with well-defined steps and feedback that establish a managerial practice for the organization, which is the basis for the organization to always be in a process of continuous improvement and to have its processes aligned with its strategic objectives [16]. The most adopted BPM lifecycle is introduced by Dumas et al., [7] that is viewed as a continuous cycle, comprising; Process Identification, Process Discovery, Process Analysis, Process Redesign/Improvement, Process Implementation and Process Monitoring. Van der Aalst [1] demonstrates three different types of business process analyses; 1) validation, i.e., testing whether the business process behaves as expected in a given context; 2) verification, i.e., establishing the correctness of a business process; 3) performance analysis (or performance evaluation), i.e., evaluating the ability to meet requirements with respect to throughput times, service levels, and resource utilization or other quantitative factors. It is clear that none of the analysis types mentioned earlier can be solely applied to a visual diagram. A formal foundation of the process model is necessary in a process analysis.

C. *Business Process Performances Measurement*

The term “Performance Measurement (Business Performance Measurement, Corporate Performance Measurement or Enterprise Performance Measurement)” means the creation and use of several indicators of various dimensions (e.g., cost, time, quality, innovation capacity, customer satisfaction), which are used to assess effectiveness and efficiency of the performance and performance potentials of different objects in the enterprise, the so-called levels of performance (e.g., organizational units of various sizes, staff, processes) [29]. Neely et al., [20] define performance measurement as the process of quantifying the efficiency and effectiveness of actions. There are four perspectives of performance called performance dimensions,

namely time, cost, quality and flexibility [13, 23]. A framework used to measure process performance as a result of improving or redesigning business processes based on those four performance perspective, namely the Devil's Quadrangle [7, 15]. Improvement or process redesign results in trade-offs between performance dimensions, for example, improving one dimension, e.g., quality, may exacerbate another dimension e.g. cost [15]. This aspect is shown from the Devil's Quadrangle that improving processes in one dimension can greatly weaken its performance in other dimensions. Awareness of these trade-offs becomes essential to achieve effective improvement/redesign for a process.

III. RESEARCH METHODOLOGY

A. Research Approach

The study used Exploratory approach which is defined as an approach that is used to investigate a problem that has not been clearly defined or if there is a lack of clear ideas related to the problem that will be encountered during the research. In this exploratory approach, two types of research methods were carried out based on the Research Questions to be answered, namely qualitative methods and quantitative methods. Qualitative Research is conducted by evaluating the existing and improved business process while quantitative research is conducted by using questionnaire to evaluate the business process performance based on user perception. The research method scheme used in this study can be shown in Figure 1.

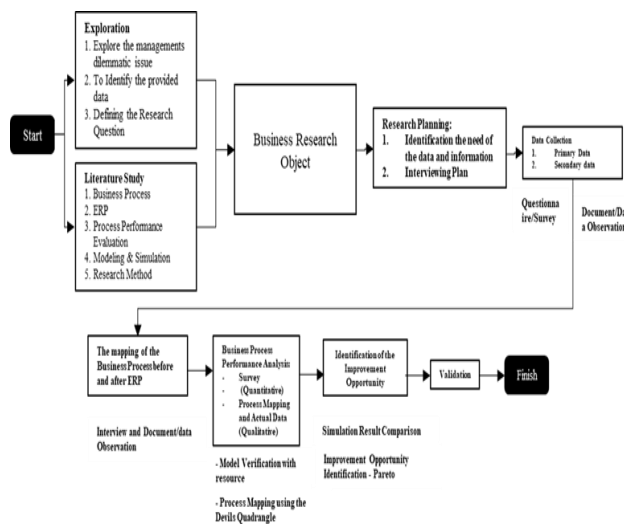


Fig. 1. The Research Method Flow Chart

B. Research Context

This research is conducted in the context of the construction industry in the Southeast Asian region, particularly Indonesia. Indonesia is chosen because it plays a crucial role as the country with the highest GDP contribution in the construction industry among Southeast Asian countries. The case study is selected from one of the largest state-owned construction companies in Indonesia, that all of its shares owned by the government. The company has been mandated by the government to develop and operate the Trans Sumatra Toll Road. The company also focuses on the

completion of national strategic projects (PSN) in accordance with predetermined targets, as well as undertaking infrastructure projects and new building projects, including projects in the New State Capital City. In order to accelerate the construction of the Trans Sumatra Toll Road, the government has provided State Capital Participation to the company, with a total amount reaching 31.3 trillion Rupiah in 2022 and planned to reach a total of 73 trillion Rupiah in 2023.

One of the business processes implemented by a company through ERP is the management of non-operational division cost. Based on the company's profit and loss reports for the years 2021 and 2022, the largest component of expenses is General and Administrative Expenses, where in 2022, 69% of these expenses were attributed to non-operational division costs. The implementation of ERP is expected to bring significant improvements to the company's business, particularly through increased effectiveness and efficiency in its processes, in accordance with the directions set by the government as the company's Shareholder. In this study, the non-operational division cost business processes that will be evaluated are generally grouped into three stages, namely the Planning & Budgeting, Procurement and Payment & Bookkeeping Stages.

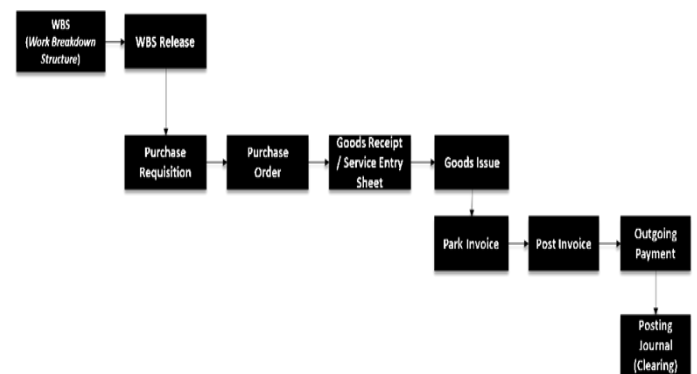


Fig. 2. Detail Stages of the management of non-operational division cost Business Process

C. Research Analysis

Data processing begins with mapping the non-Operational Division's cost management business processes before and after implementation, in the form of a BPMN flowchart along with their attributes, namely lead time, manpower and throughput. A qualitative analysis of business process map is carried out to determine opportunities for improvement and develop scenarios as recommendations for improvements that must be carried out further to support the ongoing implementation of ERP in the company. Then a survey was conducted using a media questionnaire to obtain ERP user perception data on the performance of current business processes. Furthermore, the survey data is then evaluated together with the results of the business process map analysis to determine the achievement of the previously set ERP implementation goals.

IV. RESULTS AND DISCUSSION

A. The Mapping of Business Process Results

Based on the Interview Results and Business Process Mapping, it can be concluded that the business processes have undergone modifications with the addition of activities performed through the ERP system, as well as the elimination of unnecessary activities. Furthermore, in terms of time, there is an improvement in the cycle time, which is 1.3 days faster. Prior to the ERP implementation, the process took 35.5 days, whereas after the ERP implementation, it was reduced to 34.2 days. In terms of cost, the ERP implementation required a high investment cost and led to the addition of one actor role in the process. However, it minimized other operational costs due to process automation. Nevertheless, this reduced process flexibility because if there are any changes to an activity that has already been performed within the ERP system, the activity needs to be restarted from the beginning. In terms of quality, several differences were obtained because of the redesign of the business process prior to the implementation of ERP which are the addition of tasks in the process that serve as controllers for cost compliance with the budget, and the implementation of process automation, contribute to speeding up cycle time and enhancing data accuracy.

Table 1. Business Process Mapping Analysis Results

Analysis of Results	Before ERP	After ERP	Explanation
Number of Actors	11	12	Addition of 1 ERP User for Each Division
Number of Activities	28	33	Addition of Activities: 1. Creating Work Breakdown Structure (WBS) 2. Performing Monthly Budgeting and Budget Release 3. Creating Purchase Requisition (through ERP) 4. Creating Good Receipt / Service Entry Sheet 5. Performing Park Invoice 6. Performing Posting invoice Elimination of Activity: Receiving copies of payment documents and recording accounts payable / transient costs
Cycle Time	35,5 days	34,2 days	1,3 days faster

B. Evaluation of Survey Results

Based on the Interview Results and Business Process Mapping, it can be concluded that the business processes have undergone modifications with the addition of activities performed through the ERP system, as well as the elimination of unnecessary activities. Furthermore, in terms of time, there is an improvement in the cycle.

Based on the survey results, from 441 responses filled with a Likert scale of 1 to 5 related to the performance improvement of business processes after implementing ERP, an overall average of 3.87 was obtained with a standard deviation of 0.78. This indicates that the data is homogeneous or more accurate with its average value. The average for each dimension was 3.85 for time, 3.67 for cost, 3.85 for quality, and 3.63 for flexibility. In each dimension, the standard deviation is below the corresponding mean

value. This indicates that the data is more homogeneous or accurate around their respective mean values. If the average values are depicted in Devil's Quadrangle diagram, process improvement through ERP implementation in Non-Operational Division Expenditure Management Business Process provides an improvement in the dimensions of time and quality as shown in Figure 3. However, by shifting the time and quality axes outward, it will pull other axes inward/toward an unexpected direction, which is flexibility, indicating a decrease in flexibility.

Axis/Dim.	Time	Cost	Flexibility	Quality
x	3,857143	-3,67871	0	0
y	0	0	-3,63095	3,85034
x	0,657143	-0,47857	0	0
y	0	0	-0,43095	0,65034

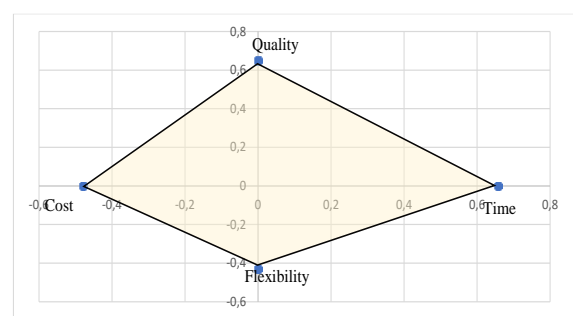


Fig. 3. Calculation to the Devil's Quadrangle

Based on the conducted quantitative and qualitative analysis, it is identified that the survey results broadly align with the qualitative analysis through interviews and business process mapping shown in Table II.

Table 2. Business Process Performance Analysis

Dimension	Qualitative Analysis (Interviews & Business Process Analysis)	Quantitative Analysis (Survey)
Cost	Minimized operational costs due to process automation	A rating of 3.67 out of 5 → On average, users agree that the process is more cost-effective compared to before.
Time	<ul style="list-style-type: none"> 4% reduction in Cycle Time. 	A rating of 3.85 out of 5 → On average, users agree that the process execution time is faster compared to before.
Flexibility	Decreased flexibility due to: <ul style="list-style-type: none"> Implementation of cost control processes Inability to make corrections in case of input errors, requiring the process to start over from the beginning. 	A rating of 3.63 out of 5 → On average, users agree that flexibility has increased. <ul style="list-style-type: none"> This is particularly related to system recovery in case of force majeure events. There is a tendency for a neutral rating regarding ease of correction in case of errors.
Quality	Improved process quality, including: <ul style="list-style-type: none"> Addition of activities involved in cost control management. Automation of activities that were previously done manually. 	A rating of 3.85 out of 5 → On average, users agree that the process quality has improved compared to before implementation. Especially in terms of output accuracy and cost control management.

C. Improvement Opportunities

Based on the actual Lead Time data within the ERP system, two processes were identified with average lead times that indicate a suboptimal Service Level Agreement (SLA):

- Park Invoice (PI) process: The Goods/Services User prepares the billing documents and obtains approval from the Head of the Non-Operational Division. Then, the ERP User in the Non-Operational Division assigns an Invoice number to the document and submits it to the accounting evaluation department.
- Incoming Invoice process: The accounting department receives complete billing documents including the hardcopies and proceeds to post them in the journal (Incoming Invoice).

From the interviews with users in these processes, an analysis of the root causes of the lead time issues in both processes was conducted. The identified root causes are as follows:

- Lack of vendor understanding of the company's SCM application, which is used for managing invoice document fulfillment administration. (Code A1)
- Insufficient understanding of non-Operational Division's goods/services users regarding the completion of standard invoice document formats required, where users need to complete the document administration in accordance with the formats provided in the company's SCM application. (Code A2)
- Preparation of Hard Copy documents to be handed over to the accounting department, extracted from the company's SCM application. (Code A3)
- Errors or misunderstandings by non-operational Division's ERP users in inputting document dates in SAP. (Code A4)
- Unavailability of approval document schedules. (Code A5)
- Presence of numerous bugs. (Code B5)

Furthermore, a quantitative analysis of the survey results was conducted to identify opportunities for improvement. From the fifteen responses regarding the perceived constraints in using ERP, the survey revealed five types of complaints that were highlighted as improvement areas by the respondents:

- Lack of user understanding or user difficulties in using the ERP system. (Code B1)
- Inability to make corrections, deletions, improvements, or customizations. (Code B2)
- Inability to view real-time remaining budget information. (Code B3)
- Processes not fully automated or involving manual steps or documents. (Code B4)
- Presence of numerous bugs. (Code B5)

From the questionnaire scores for each question, opportunities for improvement can also be identified, particularly focusing on the questions with the three lowest

scores. The questions with their respective average scores are as follows:

- “By using ERP, the number of work steps performed is fewer.” With an average score of 3.3. (Code C1)
- “Since using ERP, it is easier to make corrections in case of errors during the work process.” With an average score of 3.29. (Code C2)
- “I rarely encounter obstacles while carrying out tasks with the ERP system.” With an average score of 3.32.

From all the identified improvement opportunities that have been assigned codes, they are grouped as shown in Table III for prioritizing the constraints.

Table 3. Grouping of Improvement Opportunities

No.	Improvement Opportunities	Code
1	Lack of user understanding or difficulties in using the ERP system.	A1, A2, A4, B1
2	Challenges in making corrections, deletions, or customizations.	B2, C2
3	Inability to view real-time remaining budget information.	B3
4	Processes that are not fully automated and still involve manual steps or documents.	A3, B4, C1
5	Frequent occurrence of bugs in the system.	B5
6	Unavailability of approval document schedules	A5

The prioritization of improvement opportunities is done by adopting the Delbecq Method, based on assessments from researchers through interviews, following these steps:

- Establishing agreed-upon criteria, namely:
 - Problem Magnitude (code A), based on the frequency of occurrence of constraints.
 - Severity (code B), which assesses the impact on business process performance.
 - Ease of Implementation for the proposed improvements (code C).
 - Implementation Cost required for the improvements (code D).
- Assigning weights to each criterion with values ranging from 1 to 10, where criterion A has a weight of 8, criterion B has a weight of 8, criterion C has a weight of 6, and criterion D has a weight of 5.
- Determining scores for each criterion for each constraint, ensuring that the score does not exceed the assigned weight.
- Filling each column with the result of multiplying the weight by the score for each constraint.
- Summing up the values in each column and determining their priorities based on the total score from highest to lowest.

Table 4. Calculation of Improvement Opportunities Priority

No.	Improvement Opportunities	A	B	C	D	Total Score	Priority
		8	8	6	5		
1	Lack of user understanding or difficulties in using the ERP system.	6x8=56	7x8=56	6x6=36	5x5=25	173	1
2	Challenges in making corrections, deletions, or customizations.	5x8=40	5x8=40	2x6=12	2x5=10	102	6
3	Inability to view real-time remaining budget information.	6x8=56	5x8=40	2x6=12	3x5=15	123	4
4	Processes that are not fully automated and still involve manual steps or documents.	6x8=56	7x8=56	2x6=18	4x5=20	150	2
5	Frequent occurrence of bugs in the system.	3x8=24	5x8=40	4x6=24	3x5=15	103	5
6	Unavailability of approval document schedules	5x8=40	6x8=48	3x6=24	5x5=25	137	3

Based on the prioritized improvement opportunities, several actions can be taken as follow-up steps for continuous improvement, according to the priority order:

- Conducting awareness campaigns and training sessions for both internal and external users to enhance their understanding and usage of the ERP system and the company's SCM application.
- Establishing a policy to discourage the use of hard copy documents, which contribute to the numerous manual steps, and implementing automation for processes that are still carried out manually.
- Optimizing the use of electronic signature applications for approval processes to reduce waiting time, eliminating the need to wait for the availability of approvers' schedules to obtain physical signatures.

V. CONCLUSION

From the research that has been done, we can conclude that an analysis of the business process before and after implementation and a user perception survey on the improvement of business process performance were conducted to evaluate the performance improvement resulting from ERP implementation. The study results indicate that the implementation of ERP brings about improved performance in business processes, particularly in terms of time and quality. Additionally, the evaluation results also identify constraints, namely the users' lack of understanding, which leads to human errors and incomplete automation processes from the early stages of implementation. In addition to that, there is also the issue of the process not being fully automated, with some stages or documents still requiring manual intervention, The unavailability of a document approval schedule and inability to view the remaining budget in real-time.

Based on the evaluation findings, management needs to take follow-up actions regarding the identified improvement opportunities for ERP implementation and better business process performance, such as Conducting socialization to internal and external users to enhance understanding, Establishing policies to eliminate the use of hard copy documents, which cause unnecessary work stages, and

implementing automation for manual processes and optimizing the use of electronic signature applications for approval processes to reduce time and eliminate the need for wet signatures. The methodology used in this research can serve as a reference for future studies related to evaluating the enhancement of business process performance in ERP implementation. However, this study has limitations in terms of other actual quantitative data, such as costs and accuracy levels of outputs/processes, which could further refine the analysis. For future research, developments can be made in these areas. Moreover, advanced development of this research can include adding dimensions to the performance evaluation, more detailed mapping of business processes before and after ERP implementation, and optimization calculations of performance dimensions, such as time and cost.

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