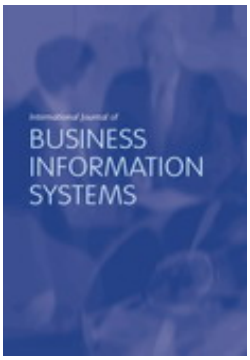

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The measurement impact of ERP system implementation on the automotive industry business process efficiency

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Abstract: ERP systems can assist businesses combine data from all corporate areas and enable centralised resource management to simplify the presentation of data, hence facilitating decision-making. However, software alone can not improve the ERP implementation efficiency of a corporation. This research aims to determine the efficiency level of business processes on the manufacturing company, before and after the implementation of an enterprise resource planning (ERP) system. The results of this study can be used by the company as a reference for evaluating the impact of ERP system implementation on business process efficiency. It is found that business processes after the ERP system implementation are more efficient compared to that prior to the ERP system implementation.

Keywords: ERP; efficiency; business process.

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1 Introduction

Enterprise resource planning (ERP) is a management information system (MIS) that is used to combine all functional areas of an organisation in order to create effective and efficient business operations. By applying the ERP system, it is desirable to store all information in a place accessible to all units of corporate functions based on the responsibility of each part. The ERP system is intended to streamline the flow of information across all business operations inside the organisation and to facilitate the establishment of partnerships with other businesses after its implementation. By combining two systems, ERP enables businesses to handle data or information on a big scale and show it as required. Without an ERP system, a company will experience difficulties with the number of applications used. Also, many transactions and information cannot be communicated effectively to each other as mentiond by Al-Mashari and Al-Mudimigh (2003).

As mentioned by Andoh-Baidoo et al. (2015), other benefits of ERP implementation are the overall business integration, the flexibility in the organisation to transform, and the improvement of turnover – creating better analysis and enhancement capabilities by using the latest technology. Mechanisation of work processes using ERP requires employees to send information to a single source. By centralising the data stored in one place, it is easier to obtain various data.

The successful implementation of an ERP system requires management support. There are several reasons why ERP projects are successful. Each company should devote time and effort to determining the ERP system's requirements. Effective ERP adoption, according to Nah (2006), involves seven important factors: vision and business strategy, change management, communication, compensation and experience of the ERP team, management support, project management, and system selection are all areas that need attention. Additionally, Plant and Willcocks (2007) identified four critical success factors: executive support, resources, inter-departmental collaboration, and vendor

support. However, as reported by Setyosari (2019) in some cases, ERP implementation does not always make the company's business more efficient, resulting in the view that the use of ERP only slows down the business processes of a company. Parr and Shanks (2000) assert that the reasons underlying the failure of ERP implementation are:

1 the operational strategy does not promote the design and development of business processes

2 the implementation period is longer than anticipated

3 the preparation efforts were unsuccessful

4 the public is ill-equipped to accept and run the new system

5 the implementation cost exceeds expectations

6 management's dedication to effective implementation

7 the next phase will be to assess the long- and short-term implications for the company selection method that will be employed

8 modifications in business processes and the installation of ERP result in organisational structure changes in the form of expanded job descriptions and the creation of new work units to support the ERP implementation

9 'change management' application is used to track and manage changes that occur after the adoption of an ERP system.

The focus of the research base on automotive manufacturing companies that produces grips through an integrated system that includes research and development of friction materials for grip assembly. The business scope of the company continues to grow along with the development of the automotive industry (Wijaya and Alianto, 2012). To improve the productivity and efficiency of business processes, these companies performed an ERP system implementation that is expected to integrate all of the company's professional areas and make business processes efficient. However, ERP system implementations are not always effective. According to Ghapanchi et al. (2008), many companies have invested in the implementation of ERP systems, but a large number of the companies wasted millions of dollars as a consequence of the implementation and adoption of failed ERP. Several failures returned on the selection of an improper ERP system.

The success of ERP implementation is very important for the progress of the company in the future, but such success does not rule out the possibility that implementation of ERP makes the company's business process inefficient. Therefore, the topic that reported and discussed in this research is 'The measurement impact of ERP system implementation on the automotive industry business process efficiency' (Shatat, 2015).

The scope discussed in this research is the business process before and after the implementation of ERP in the planning division. The focus of the research will be directly related to the ERP system.

2 Survey literature

2.1 Enterprise resource planning

ERP according to Garg (2010) is a business management system that covers all corporate activities and is driven by a variety of linked software modules that support the organisation's internal business processes. A typical ERP software for manufacturing organisations often starts with data processing, which includes tracking sales and inventories as well as personnel needed and estimating raw material needs [O'Brien and Marakas, (2010), p.273]. As mentioned by Wijaya and Damayanti. (2011). the ERP system is composed of five primary components: production planning, integrated logistics management, human resources management, sales distribution, accounting, and finance.

According to Wijaya and Darudiarto (2009, p32), ERP is a computer-based system developed and designed to process a corporate transaction and facilitate planning, production, and response to consumers in an integrated, real-time manner. Further, as Wijaya and Damayanti (2011, p.914) assert, ERP is a shortcut of information technology to assist companies in managing business processes using a shared database and management report section.

From the above definition, it can be concluded that ERP is a computer-based system designed as the backbone of a corporation to automate many corporate transaction processes which are integrated in real-time.

2.2 Business process

Business process is a set of instruments to organise an activity and improve the understanding of the relevance of an activity (Weske, 2007). It is a set of activities or activities designed to produce a specific outcome for a particular customer (Sparx Sytem, 2004).

Business process, as mentioned by Hammer and Champy (1993) and Weske (2007), is a collection of actions that take one or more inputs and provide a beneficial result for consumers. According to Ayman Meidan et al. (2016), business processes are a key element when integrated with a company; business processes are closely linked with the company to determine the path of choice to succeed.

2.3 Efficiency

According to Aalst et al. (2003), efficiency is defined as 'the relationship or ratio between the output factor (goods and services) and the input factor (rare) in a work unit, or determination manner (effort, work) in operating anything (by avoiding time, effort, and money waste).' Meanwhile, Mulyadi (2007, p.63) states that 'efficiency is the degree to which (effort, labour) is carried out precisely in order to prevent wasting time, effort, and money'. Efficiency is sometimes defined as the ratio of input to output or cost to profit. Meanwhile, according to Hasibuan (2005, p.233), citing, H. Emerson's states that 'efficiency is the best ratio of input to output (the outcome of profit divided by the resources utilised), as well as the best results obtained with limited resources. In other words, the link between accomplished tasks'.

Measurement of efficiency using regression and ratio analysis compares the input used with the output produced. However, the weakness of ratio analysis will be seen where there are many inputs and many outputs. Efficiency can be defined as the ratio between output (output) and input (input), or the number of outputs generated from one input used. Efficiency can be estimated using data envelopment analysis (DEA) techniques that have different characteristics from the concept of efficiency in general.

3 Methodology

The purpose of this study is to assess the effect of the ERP system adoption on Automotive Industries, and whether or not it improves business operations. In the study, the DEA approach was applied. DEA is a non-parametric linear programming approach that utilises a variety of software packages, including Banxia frontier analysis (BFA) and Warwick for data envelopment analysis (WDEA) as shown in Alimul Hidayat (2019). In the study, the DEA approach was applied. Both software will lead to the same result (Kurnia, 2004). Basically, DEA analysis technique is designed specifically to determine a DMU's relative efficiency under a variety of input and output scenarios. These conditions as mentioned on Ghapanchi et al. (2008). are usually difficult to be perceived perfectly by other efficiency measurement analysis techniques. Measurement using DEA method aims to identify whether business process after ERP implementation is more efficient than before ERP implementation. To measure the efficiency of business process after ERP implementation, it is necessary to obtain real company data, analyse the results of the data collection, and then determine the input and output variables. Measurement is done using Frontier Analysis software. A decision-making unit (DMU) is said to be efficient when a score of 100% is generated. If a DMU obtaines a 0%–99% score, the DMU is not yet efficient. The results will be analysed to reveal whether the business process after the implementation of ERP is more efficient than before the implementation of ERP.

In this research, we need a framework to answer whether the business process after ERP implementation is more efficient than the business process before the implementation of ERP. As mentioned on Hassan et al. (2011), first, a literature study is used as a reference to measure the efficiency level of business processes before and after the implementation of ERP systems. Next, the researchers determine the input and output variables; the criteria applied for input and output selection are very subjective. This is because there is no specific rule in determining the selection of input and output variables. The next step is to collect the data needed for the measurement of efficiency by using DEA method. After that, measurement is done, which consists of DMU before implementation of ERP and after implementation of ERP by DEA. The DEA method is used to measure efficiency. In this method, there is a unit of measure called DMU, and DMU is taken from 3 periods before and after the implementation of ERP. Each DMU prior to ERP implementation is compared with DMU after ERP implementation. Then, the analysis of the measurement results of the efficiency level of the input and output variables is performed. After that, the researchers conclude the results of this study and provide advice to automotive industries to be able to improve business processes that have not been efficient to improve the efficiency of the business process.

3.1 Data envelopment analysis

According to Kurnia (2006), DEA analysis is especially developed to determine a production unit's relative efficiency under situations of many inputs and outputs, which are sometimes difficult to deal with correctly using conventional technical efficiency assessment techniques.

DEA is a non-parametric method that is mostly based on linear programming. DEA begins with identifying the units to be assessed, as well as their inputs and outputs. Following that, researchers compute the value of productivity and discover which units do not efficiently utilise inputs or create outputs. The productivity measured is comparative or relative, since it compares just the same set of data's measurement units. Additionally, the analytical tool DEA is the optimal option Karimi et al. (2007).

The physical relationship between output and input is often called the production function. As reported by Saleh (2020), Efficiency can be defined as the ratio between output and input, or the number of outputs generated from one input used. Efficiency can be estimated by the data analysis envelopment analysis (DEA) technique, which has a character different from efficiency concept in general (approximated by the parametric approach, such as regression).

Sunarto (2010) has summarised several stages in the DEA analysis:

a Table of efficiencies (Radial): This analysis shows that DMU (economic activity unit) is the most efficient. Efficiency is indicated by the optimal value of the objective function developed from linear programming. The value of the goal function 100% means that the DMU (economic activity unit) is efficient, while less than 100% means inefficient.

b Table of peer units: This table is used to determine if an inefficient DMU (economic activity unit) will be shown how to achieve efficiency level by looking at peer DMU (unit economic activity) as a reference or guideline to achieve efficiency level.

c Table of target values: This analysis is used to determine what percentage of efficiency already occurs for each DMU (economic activity unit) from either the input structure or the output structure. This table shows the actual values and targets to be achieved from each input or each output. If the actual value is equal to the target value, then the efficiency of each input or output has occurred. Conversely, if the value between the actual and the target is not the same, then the efficiency has not been achieved.

Ramanathan (2003) described the procedure performed after the calculation of efficiency with DEA. In his view, it is very important to verify the efficiency calculation results by using sensitivity analysis. In some cases, the DEA's measurement output is sufficient for drawing conclusions. However, some other cases often require further analysis of the DEA output.

Sensitivity analysis is an analysis related to discrete parameter changes to see how much change can be tolerated before the optimum solution begins to lose its optimality. Sensitivity analysis of DEA findings is an extreme-point approach, since the frontier efficiency is determined by the actual performance of the DMU. A direct consequence of this aspect is that the efficiency of DEA becomes very sensitive to small errors. Because DEA is a nonparametric technique, statistical hypothesis testing becomes difficult. Therefore, as with other modelling techniques, the output produced by DEA must be

carefully viewed and should only be utilised after a thorough sensitivity analysis (Sunarto, 2010).

According to Sunarto (2010), it is possible that the DMU obtains a utility value only by improving its performance within a certain output framework and ignoring others. The DMU is said to be efficient, although it does not improve its performance in the perspective of its entire output. However, such a DMU is not a peer for most inefficient units. If a DMU was initially identified as efficient by DEA, then a complement of sensitivity analysis should be done by checking the number of inefficient DMUs that are peers. If the number is large, then it is said that the DMU is really efficient. The efficiency of a DMU with only a few or a few peers should be carefully examined. According to Paradonsare et al. (2014), this can be done by ignoring or not including one input in the analysis in turn.

3.1.1 Research objects

The object of this study is the existing business processes in the planning division at 3 periods before and after the implementation of ERP, because this study will evaluate the effectiveness of business operations before to and after the adoption of an ERP system. As mentioned on Sukmadinata (2019), in the planning division that becomes the object of research, the employees involved in the business process run the process in making customer schedule, production planning, budget MRP, and shipment. Number of customer schedule, number of finished good, total sales part, where. All of these objects are part of the business process in the Planning division which will be used as a DMU – that is, 3 periods before and after the implementation of ERP, DMU – consisting of before the implementation of ERP system (before_ERP) and after the implementation of ERP system (After_ERP), and will be measured to determine the level of business process efficiency in the company.

DMU (before_ERP) consists of 3 months prior to the implementation of ERP system in January, February, and March 2020. DMU (after_ERP) consists of 3 months after the implementation of ERP system in April, May, and June 2020. The method used to measure the level of efficiency before and after the implementation of ERP is by using DEA. The detail of period before and after ERP system implementation is shown on Table 1.

Table 1 Period before and After ERP system implementation

Period	*Description*
Januari_2020_before	The period before the implementation of ERP system in January 2020
Februari_2020_before	The period before the implementation of ERP system in February 2020
Maret_2020_before	The period before the implementation of ERP system in March 2020
April_2020_after	The period before the implementation of ERP system in April 2020
Mei_2020_after	The period before the implementation of ERP system in May 2020
Juni_2020_after	The period before the implementation of ERP system in June 2020

In selecting input and output, variables are very subjective. There are no special criteria, and there are no specific rules for determining the selection of inputs and outputs (Ramanathan, 2003).

Variable input is defined as a utilised resource that affects DMU performance, while the output variable is the result of DMU activities.

Input variable

A Number of employees in the planning division: The variable number of employees in the planning division refers to employees who run the business process, ranging from making the production schedule, purchasing, planning, budgeting MRP, up to shipping finished goods. This variable is used as input variable in this research because it is involved in the business process. In the absence of human resources, the company's business process cannot be executed.

B Working hours of employees on planning division: The variable of number of working hours of employees is the accumulation of employee working hours in the planning division for 1 month. This variable is used as an input variable in this research because the variable indicates the number of working hours needed to do business operational activities in the planning division is show on Table 2.

Output variables

A Number of finished good on planning division: Finished goods are goods produced that are ready to be distributed. This variable is used to find out how many finished goods are ready to be distributed, and this variable is the result of the business process done in the planning division. Considering that, the finished good variable is used as output variable.

B Number of sales part in planning division: The variable of sales part is the number of finished good sold. This variable is used to find out how many finished goods are sold, and this variable is the result of the business process performed by the employees in the planning division. Considering that, the sales part variable is used as the output variable as shown on Table 3.

Table 2 Input variable

Variable	*Description*
EMP	Number of employees planning division (in person)
HOUR	Number of employees work hour division planning (in hour)

Table 3 Output variable

Variable	*Description*
SALES_PART	Number of Sales Part planning division (in IDR)
FG	Number of Finished Good (in unit)

4 Analysis

Measurement of efficiency of business processes prior to and during the introduction of the ERP system, the DEA approach was used in conjunction with the BFA program. The

basic idea behind DEA is to compare input and output data from a data organisation, also known as a DMU, with other input and output data from comparable DMUs. This comparison is made in order to determine the efficiency of the system. The efficiency determined by the DEA method is a relative value. So, it is not an absolute value that a unit can achieve. The best performing DMUs will have an efficiency level expressed in 100% value, while other DMUs below will have varying efficiency values, ranging from 0% to 100%.

Table 4 Value of input and output variables for each period

Period	*Input/output variable*	*Value*
Jan_Before	EMP	23
	HOUR	6,780
	FG	1,393,929
	SALES_PART	20,883,437,300
Feb_Before	EMP	23
	HOUR	6,980
	FG	1,314,550
	SALES_PART	19,718,250,000
Mar_Before	EMP	23
	HOUR	7,692
	FG	5,557,703.00
	SALES_PART	153,785,960,867.16
Apr_Before	EMP	22
	HOUR	6,690
	FG	1,416,514
	SALES_PART	20,503,204,000
May_Before	EMP	23
	HOUR	6,758
	FG	2,118,282
	SALES_PART	31,774,240,000
Jun_Before	EMP	23
	HOUR	6,658
	FG	2,072,600
	SALES_PART	32,125,300,000

In this study, the output maximisation method is selected. The input variables selected in this study are the number of employees in the planning division in units of people, and the number of employees who work hour in hour. These input variables are defined as utilised resources that affect the performance of DMU. Without the human resources, the company's business process cannot be executed. The variable indicates the number of working hours required to perform business operational activities in planning division while for the output, variables consist of the number of finished goods in unit and sales part in IDR. The variable of number of finished good is used to know how many finished goods are ready to be distributed, and this variable is the result of business process in

planning division. Sales part variable is used to find out how many finished goods are sold. This variable is the result of the business process performed by employees in the planning division.

Here are the results of DEA measurements on each DMU as shown on Table 4, where the measurement results illustrate the efficiency values of each DMU.

Based on Table 5, the results of DEA measurement for May_After period and Jun_After period after ERP, system implementation is efficient. The efficient results are obtained because it maximises input value and output value so as to produce 100% perfect efficient value.

Table 5 The results of measurement efficiency level for each period

Division	*Period*	*Score*	*Description*
Planning	Jan_Before	65.8%	The period before the implementation of ERP system in January 2020
	Feb_Before	66.4%	The period before the implementation of ERP system in February 2020
	Mar_Before	62.1%	The period before the implementation of ERP system in March 2020
	Apr_After	72.3%	The period before the implementation of ERP system in April 2020
	May_After	100.0%	The period before the implementation of ERP system in May 2020
	Jun_After	100.0%	The period before the implementation of ERP system in June 2020

Table 6 The results of measurement efficiency level for each DMU

Division	*DMU*	*Score*	*Description*
Planning	Before_ERP	72.0 %	The period after the implementation of ERP system
	After_ERP	100.0 %	The period before the implementation of ERP system

From the calculation of efficiency value from each DMU in planning division, the result of efficiency measurement at DMU before implementation of ERP is 72.00% and DMU after implementation of ERP is 100%. The detail is shown on Table 6.

In the efficiency measurement using the DEA method, a DMU is efficient if it scores 100%; if DMU obtains a 0%–99% DMU score, it is not yet efficient. A DMU is efficient if all input components can produce an output value with a maximum value. The use of input variables includes the number of employees and the number of employees working hours. Meanwhile, the increment of output variables includes the number of sales parts and the number of finished goods.

4.1 Targeting improvement of input-output

Attempts to improve the input-output are done so that the inefficient DMU becomes efficient. As for the efficient DMU, this effort is done to maintain its level. The input-output improvement is done by setting the input-output target.

There are two options for setting output and output improvement targets for an inefficient DMU to be efficient – i.e., input maximisation and output maximisation. Input maximisation sees how far value from input can be reduced and keep output value, while output maximisation sees how far output value can be added by maintaining input value.

This study selected output maximisation method because the consideration of the majority of variables is not easily reduced as the number of employees. The process to reduce the value of these variables is highly selective.

Based on the results of DEA measurement for May_After period and Jun_After period after ERP, system implementation is efficient; efficient results are obtained because it maximises input value and output value so as to produce 100% perfect efficient value. The detail is shown in Table 7.

Table 7 Target variable input and output variables in planning division

DMU	*Input/output variable*	*Value*	*Target*	*Potential improvement*
Jan_Before	EMP	23	23	0.00 %
	HOUR	6,780	6,780	0.00 %
	FG	1,393,929	2,118,282	51.96 %
	SALES_PART	20,883,437,300	31,774,240,000	52.15 %
Feb_Before	EMP	23	23	0.00%
	HOUR	6,980	6,758	–12.14%
	FG	1,314,550	2,118,282	61.14%
	SALES_PART	19,718,250,000	31,774,240,000	61.14%
Mar_Before	EMP	23	23	0.00%
	HOUR	7,692	6,758	0.00%
	FG	5,557,703,00	5,586,976.64	7.16%
	SALES_PART	153,785,960,867,16	154,559,841,457.87	32.66%
Apr_Before	EMP	22	22	0.00%
	HOUR	6,690	6,464	–3.38%
	FG	1,416,514	2,026,183	38.35%
	SALES_PART	20,503,204,000	30,392,751,304	48.23%
May_Before	EMP	23	23	0.00%
	HOUR	6,758	6,758	0.00%
	FG	2,118,282	2,118,282	0.00%
	SALES_PART	31,774,240,000	31,774,240,000	0.00%
Jun_Before	EMP	23	23	0.00%
	HOUR	6,658	6,658	0.00%
	FG	2,072,600	2,072,600	0.00%
	SALES_PART	32,125,300,000	32,125,300,000	0.00%

From the calculation of efficiency value for each DMU in planning division, DMU before implementation of ERP is 72.00%, and DMU after implementation of ERP is 100%.

5 Conclusions

ERP systems can help companies integrate information from all different business functions and provide centralised resource management to simplify the presentation of data, making it easier for the companies to make decisions. However, software alone does not increase a business's efficiency in the deployment of ERP.

While several instances of ERP system adoption are proclaimed successful, ERP implementation does not always result in business advantages. Certain businesses struggle with the installation of ERP systems. Failure of the ERP system or the adoption of ineffective systems will always result in significant losses and may even result in bankruptcy. The result of this research was shown that the adoption of ERP in Automotive Industry provide certain level of impact DMU that show with significant improvement on the business process. The result was support the finding of Davenport (1998), Soh et al. (2000), Chen (2001), and Davenport et al. (2004).

Based on the efficiency measurement results that have been analysed in the previous part, it can be concluded that the DMU after the implementation of ERP is more efficient than that before the implementation of ERP. We can observe the results of measuring each DMU before and after ERP deployment; the DMU measured before to ERP implementation is 72.00%, whereas the DMU measured after ERP implementation is 100.00%.

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