Indonesian Journal of Business Analytics (IJBA)
Vol. 4, No. 4 (August) 2024:1613-1627

Analysis of Business Process Re-Engineering in the Implementation of Robotic Sorting Machines in the Middle Mile Process at PT Pos Indonesia (Persero)

Imam Pujono[1], Tukhas Shilul Imaroh[2]
Universitas Mercubuana

Corresponding Author: Imam Pujono : imampujono28@gmail.com,

ARTICLEINFO

Keywords: Business Process Re-engineering (BPR), Implementation of Robotic Sorting Machine

Received : 14, June
Revised : 30, July
Accepted: 28, August

ABSTRACT

PT Pos Indonesia faces challenges in improving courier service business processes due to business change trends. This study aims to identify and analyze inefficiencies in the middle mile supply chain business process of PT Pos Indonesia Processing Centre Surabaya and determine the number of robotic mega bots needed to improve efficiency. The research method uses quantitative information, observations, interviews, computer simulations, Value Stream Mapping process flow charts, and Business Process Reengineering concepts. The results showed that the use of mega bot robots had a positive and significant impact on the company's reputation, and the sorting process carried out using robotic mega bots was appropriate because it had a significant impact on the effectiveness and efficiency of business process improvements at PT Pos Indonesia (Persero).

DOI: https://doi.org/10.55927/ijba.v4i4.10357
ISSN-E: 2808-0718
https://journal.formosapublisher.org/index.php/ijba/index

INTRODUCTION

A major challenge faced by almost all business entities is good leadership and sustainable transformation in line with its vision. Increasingly fierce competition requires digitization and regeneration so that the Company's prospects become well-directed and able to compete. The increasing role of technology in the Company's business ecosystem requires the company to have a digital mindset in both business and internal processes, so that it can become an agent of change that is able to give color to every dynamic and be resilient in the face of change in order to continue to be able to adapt in a digital world.

In the midst of increasingly fierce competition and growth in the courier logistics and financial services industry, PT Pos Indonesia (Persero) seeks to enlarge its current market share. Of course, this effort needs to be done carefully and must be accompanied by good supervision. Comprehensive digitalization is needed both in business and internal processes. Efforts to continue to encourage increased capability so that the digital mindset is embedded in every policy and strategy implemented.

By considering the quality and efficiency factors of the process as an effort by PT Pos Indonesia to increase customer satisfaction, business process engineering efforts involve many parties and many factors in the process including supply chain management (SCM). Supply Chain Management has a very important role in a business entity undertaken by a company. With the implementation of supply chain management, industries can overcome losses and instead can gain above-average profits.

The main source of customer dissatisfaction arises when they cannot strike a balance between supply chain sustainability (SCM), delivery time, product cost, and delivery product quality. Lean business processes are the lifeblood of the business itself. The company's business improvement efforts are greatly influenced by the factor of how much the company's ability to streamline its business processes to be more efficient and effective and able to create renewable business processes, which can provide more value (value added) compared to other courier products and services. In all these efforts, it is necessary to apply the science of Business Process Re-engineering (BPR). Business Process Re-engineering (BPR) in its management really requires integration, synergy between departments, and even between external supply chain actors and their networking.

In principle, Business Process Re-engineering (BPR) rests on an idea that is completely different from the previous model or pattern, or it can be said that the current process is no longer relevant to customer needs, old-fashioned, outdated so it needs to be abandoned (Aprilitasari et al., 2020a). The dimension of business process automation can involve the application of machines in business processes with the aim of improving process efficiency through the utilization of Robotic Process Automation (RPA) Technology. Humans as social creatures seem to be forced to want to do manual processes repeatedly and

tediously, which can lead to frustration and over time will become error-prone. In industrial robot applications, the intelligence of industrial robots can be distributed in such a way that local processing of sensors, vision images, motion, logic, and communication collaboratively produces the desired system-level performance (Day, 2018).

Based on the existing phenomenon, the research uses Business Process Re-engineering (BPR) and Value Stream Mapping because some of the advantages of the BPR model as a process reference model are a balanced approach, the ability to integrate business process reengineering, benchmarking and best practice analysis into the supply chain framework in various dimensions and the ability to separate value added and non-value added. The purpose of this research is to determine and analyze the location of inefficient processes and how to improve them, to find out how many robotic machines are needed if there is an increase in the number of production of 1,000,000, shipments per day, and can provide recommendations to management.

THEORETICAL REVIEW

Supply Chain Management

Supply Chain Management (SCM) is a management activity that aims to obtain raw materials, transform raw materials into semi-finished or finished goods and distribute these goods to consumers (Render and Munson, 2017). This chain is also a network of various organizations that are interconnected for the same purpose. It can also be said that the Supply Chain is an organizational system of people, technology, activities, information, and resources involved in the process of delivering products/services from suppliers to consumers. Activities in the supply chain naturally transform resources, raw materials and basic components into finished products that will be distributed to end consumers.

Business Process Re-Engineering

Pujawan and Er (2017) explain that strategic objectives can be achieved if they have the ability to operate efficiently, create quality, be flexible and innovative. Each of these customer aspirations can be supported by one or more strategic capabilities of a supply chain. Business Process Reengineering is needed by all business entities to be more effective and efficient. Reengineering is used to identify, analyze, and redesign the core business processes of a company/organization with the aim of achieving dramatic improvements in critical performance measures such as cost, quality, service and speed (Aprilitasari et al., 2020a).

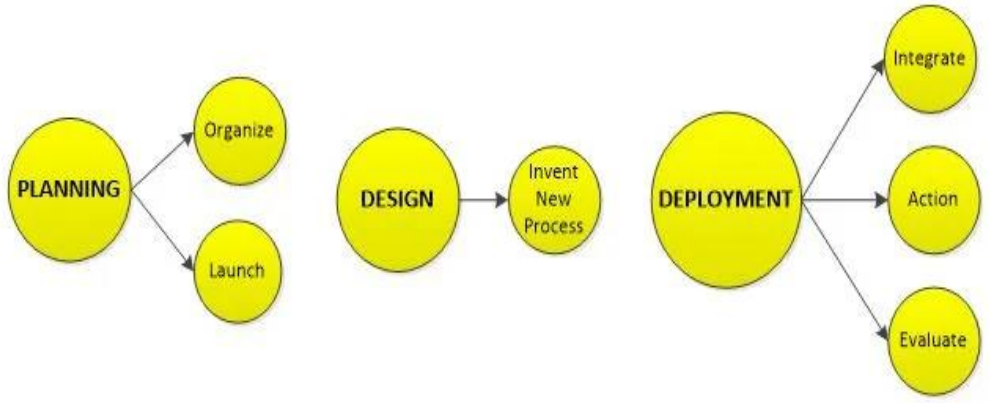

Figure 1. The BPR Process

The meaning of the word dramatic means that re-engineering is not about achieving additional improvements, but also about achieving quantum leaps in terms of company performance dramatically. Process has the meaning of a set of activities or activities that require one or more types of inputs and produce outputs that have value for service user customers (Richardus Eko Indrajit & Djokopranoto, 2016). The rapid advancement of information technology has made information technology one of the main components in the new company format as a result of Business Process Reengineering (Richardus Eko Indrajit & Djokopranoto, 2016).

In a re-engineering process, it is sometimes necessary to utilize or touch the current information technology, machines, tools that can provide a very important role. Re-engineering a business process must certainly focus on the process of innovation, speed, service and quality. Reengineering must be able to prepare processes that are very effective and efficient so that they can lead to radical improvements. There are five stages in conducting business process reengineering (Aprilitasari et al., 2020b):

1. Understand the ongoing process,
2. Finding the weak points of the current process,
3. Investigate redesign alternatives,
4. Search for information needed to support the business process reengineering process,
5. Conducting a feasibility test study on the latest process design.

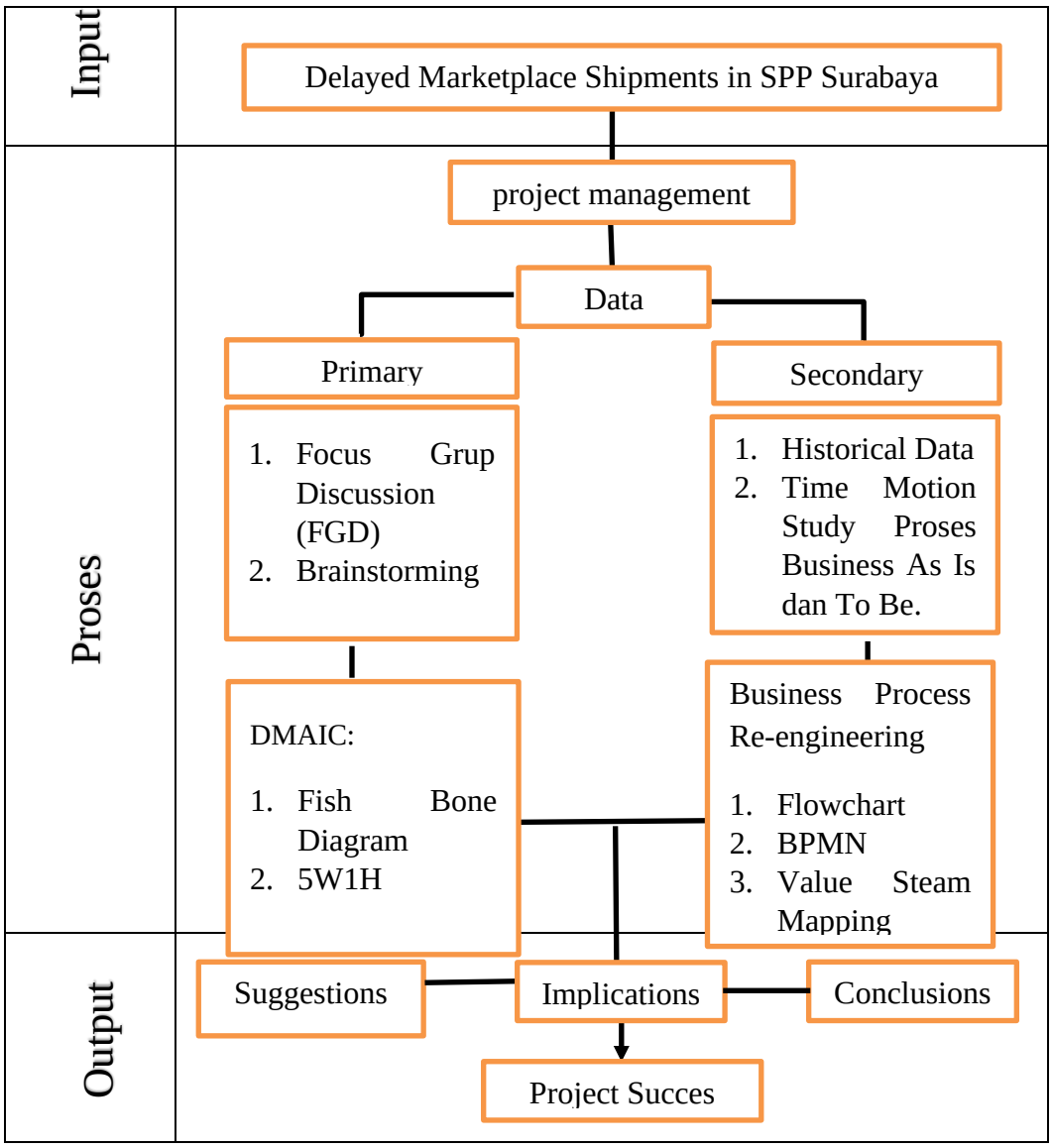

Figure 2. Conceptual Framework

Previous Research

Tabel 1. Previous Research

No.	Researcher (year)	Tittle Method	Research Results
1.	Andrea Gažová (2022)	*Effect of Business Process Management on Level of Automation and Technologies Connected to Industry 4.0*	The results show that companies that implement BPR at a higher level also implement technologies and automation related to Industry 4.0 at a higher level. This suggests that BPR can help companies prepare for Industry 4.0 and digital transformation. In addition, the

		Survei kuantitatif dengan Quantitative survey using questionnaires as a data collection tool	study also shows that companies that implement BPM at a higher level experience benefits such as improved production efficiency and performance monitoring, cost savings, and increased implementation of automated production. However, the study also shows that there are some issues or risks that occur when implementing automation technologies, such as high initial costs or problems connecting new automation solutions with existing systems and infrastructure.
2.	Abeer Al Hattami (2018)	*Reengineering and Automation of Business* *Processes: A Case Study with Universities travel* *Request Business Process* The implementation of business process reengineering using the Bizagi platform is presented, to improve the travel request business process.	Business process reengineering is an effective approach to improve company performance by radically and thoroughly changing existing business processes. Business process automation is the use of technology to automate parts of the business process that can improve efficiency and productivity. Business process automation can be the first step in adopting a culture of continuous transformation, increasing transparency, and becoming a source of training for employees. Business process reengineering and business process automation can work synergistically to achieve better results in terms of company performance and customer satisfaction.
3.	Chia-Peng Day (2018)	*Robotics in Industry — Their Role in Intelligent Manufacturing*	The research presented in this document focuses on the role of robotics in smart manufacturing. It discusses the history of the industrial revolution and the impact of robotics on increasing productivity in the

		Automation robotics for the 3C industry	manufacturing industry. The document also highlights the importance of basic expertise and skills in the robotics industry. The report mentions the opportunities provided by the Internet of Things and the potential of non-traditional robot makers. Overall, the research emphasizes the need for persistent efforts, collaboration, and innovation to achieve real results in the field of robotics.
4.	Leonel Patrício (2022)	*Literature review of decision models for the sustainable implementation of Robotic Process Automation* Survei kuantitatif dengan Quantitative survey using questionnaires and past primary data as data collection tools	Robotic Process Automation (RPA) is a rule-based system for automating business processes by software bots that mimic human processes. interaction to free employees from tedious work. It has been verified in the literature that there are very few works related to RPA decision support models. This technology is in rapid growth and therefore, it becomes important to study the evaluation of RPA implementation. The objective of this work is focused on a literature review for the identification and analysis of Robotics Process Automation implementation models. This work analyzes several models or studies available in the literature and, in addition, analyzes them from a point of view related to the Triple Bottom Line (TBL) regarding environmental, social and economic impacts.
5.	Fakhreddin F. Rad (2022)	*Industry 4.0 and supply chain performance: A systematic literature review* *of the benefits, challenges, and critical*	This study investigates and consolidates the benefits, challenges, and success factors of 11 technologies that characterize Industry 4.0 with respect to supply chain performance through a

		success factors of 11 core technologies Literature review analysis of 221 articles	systematic literature review. The study covers 221 articles from more than 100 different journals, comprising Internet of People, Internet of Things, cloud computing, big data technology, blockchain, augmented reality, automation, robotics, additive manufacturing, simulation, and semantic technology as core technological components of Industry 4.0. The most frequently discussed implications in the literature reviewed worldwide11 of core technologies are integration and optimization in terms of benefits, high costs and human resources in terms of challenges, and top management alignment and support in terms of critical success factors.

Source : Processed by the author

METHODOLOGY

This research is conducted with a scientific approach to test hypotheses using a structured scientific method of collecting quantitative data that can be measured and tested statistically. This research often uses measurement instruments, inferential statistics, and numerical analysis.

Population

Population is the total collection of elements that are expected to be studied and then expected to draw conclusions, where the elements in the population are individual participation or an object that is taken to be known (Cooper and Schindler, 2016). The population in this study is the entire set of business processes or supply chains at Pos Indonesia.

Sample

The sample is defined as part of the population which is the actual source of data in a study. In other words, the sample is part of the population to represent the entire population, in this study the sample was carried out by "Systematic Sampling", namely the sampling technique based on the order of the population members who have been given the order in this case is the order of the series of business processes as is before using the robotic sorting machine starting from the Transportation Section, Process Section and Distribution

Section and the business process to be after the implementation of the robotic sorting machine.

Data Collection

Data collection was carried out by direct observation to SPP Surabaya. In addition to direct observation by taking time motion study data, secondary data collection is also carried out by analyzing previous reports. Data taken in the form of time data for each sorting process, personnel data, facility data and supporting support. Time motion study data collection was carried out with a repetition of 30 observations.

RESULTS

To determine the Poisson delay time with a value of 22 packet arrivals per minute for input at the source block. To determine the delay time of the robotic process work element, a per-work-element time distribution test was conducted. From the robotic process work element time distribution test, the triangular distribution (a, m, b) was chosen as the process time distribution, where the value of a = lower limit of process time, m = average value of process time, b = upper limit of process time.

Table 2. statistical distribution of each work element

No.	Elemen Kerja	Variabel Anylogic	Distribusi
1.	Pengambilan Paket	ambil_paket	Triangular (3.06, 3.77, 5.65)
2.	Peletakan Paket	taruh_paket	Triangular (2.87, 3.89, 6.15)
3.	Scan Barcode	scan_paket	Triangular (0.57, 1.53, 1.27)
4.	Perjalanan Paket	perjalanan_paket	Triangular (4.42, 10.72, 42)
5.	Peletakan Paket	drop_paket	Triangular (0.4, 0.5, 0.62)

From the results of the initial model, to complete 2000 packages, the fastest average process time in the robotic process is 13.9 seconds, while the average process time is 29.19 seconds and the longest time in the robotic sorting process is 52.9 seconds. The process time results from the initial model were validated using actual process time data from the observation process using the downtime method. A total of 30 data simulation model results were compared with actual process time data to test the average difference.

Table 3. robotic sorting process time actual data and simulation result data

No.	Data Aktual (menit)	Data Simulasi (menit)	No.	Data Aktual (menit)	Data Simulasi (menit)
1.	17,9	20,1	16.	35,7	23,6
2.	16,9	20,0	17.	21,3	24,2

3.	39,0	22,2	18.	28,2	17,6
4.	16,5	21,2	19.	18,7	23,9
5.	25,8	19,3	20.	22,3	19,6
6.	16,3	24,5	21.	39,0	18,4
7.	16,0	17,5	22.	21,6	22,4
8.	17,8	23,1	23.	18,0	22,0
9.	18,0	21,6	24.	20,2	21,9
10.	27,1	18,9	25.	27,7	19,5
11.	13,9	25,0	26.	19,0	23,6
12.	26,5	24,2	27.	15,4	16,7
13.	16,0	21,1	28.	21,6	18,6
14.	25,7	19,5	29.	30,8	18,1
15.	29,7	16,0	30	26,1	18,1

The results of the calculation of the average value and standard deviation of actual data are 22.94 ± 6.9 minutes while for simulated data is 20.74 ± 2.5 minutes. At the model validation stage, it is checked whether there is a difference between the actual data and the simulated data using a confidence level of 95% and an error rate of 5% (α = 5%). The results of the mean difference test show that there is no significant difference between the actual data and the simulated data as indicated by the p value = 0.1. When the p value is greater than 0.05, it means that the simulated data is the same as the actual data obtained from the measurement of downtime, meaning that the model used is valid.

DISCUSSION

Recommendations for improvement of the problem of over time delivery are described at the improve stage with the 5W + 1H approach. And after implementing the robotic sorting machine, the increase in production has increased significantly, as can be seen from the table below.

BEFORE					AFTER				
Bulan	Jml Transa	Jml LDR	% LDR	% Kinerja	Bulan	Jml Transa	Jml LDR	% LDR	% Kinerja
2021-01	51.607	3.899	8%	92%	***2023-08***	301.200	4.428	1%	99%
2021-02	43.921	3.719	8%	92%	***2023-09***	345.404	4.628	1%	99%
2021-03	68.849	4.511	7%	93%	***2023-10***	392.414	6.318	2%	98%
2021-04	92.301	6.929	8%	92%	***2023-11***	365.780	7.023	2%	98%
2021-05	64.372	5.296	8%	92%	***2023-12***	442.691	9.916	2%	98%
2021-06	99.005	5.866	6%	94%	***2024-01***	300.245	6.425	2%	98%
2021-07	92.914	5.629	6%	94%	***2024-02***	304.590	6.396	2%	98%
2021-08	150.697	10.579	7%	93%	***2024-03***	347.948	6.715	2%	98%
2021-09	111.759	7.466	7%	93%					
2021-10	225.446	10.237	5%	95%					
2021-11	166.424	9.642	6%	94%					
2021-12	121.494	7.042	6%	94%					

Figure 3. increase in production quantity 2023 - 2024

performance indicators of the sorting section after the implementation of the sorting machine

The calculation of 7 indicators of post-implementation analysis of robotic sorting machines is carried out by looking at the to be condition or the condition when the fine sorting process has switched to using robotic power. The

implementation of fine sorting using robotic power is one of the activities in the SPP Surabaya business process which is expected to minimize the risk of sorting errors in the manual fine sorting process. robotic sorting speed is 124 items/minute which is obtained from 20,975 items processed per day and divided by the total time needed to sort for 1 cycle is 21 minutes on each shift and it is also known that there are 8 shifts per day so that the mathematical equation is obtained (20,975 items/21 minutes*8 shifts = 124 items/minute). Furthermore, the manual sorting accuracy is 100% which is seen from the number of items that are sorted correctly this is because the sorting machine has been designed to read the barcode (postal code) on the item accurately and enter it according to the regional postal code basket.

Then, the efficiency of resource utilization is seen in terms of the efficiency of use on the robot which is 66% obtained from the mathematical equation (41,950/8) items / 40 robots = 66%) and in terms of worker efficiency of 87.4% obtained from the percent of the mathematical equation (41,950/8) items / 30 workers = 87.4%). After that, the quality of sorting results seen from the percentage of sorting errors is 0% due to the robotic system that automatically scans the barcode code on the item and puts it into the bag based on the pool code.

Table 4. total time to complete sorting (minutes)

Waktu yang dihabiskan/40 robot (menit)		
tercepat	moderate	terlama
22,67	48,30	88,17
18,13	38,80	70,53
9,07	19,43	35,27

Based on the comparison results with the robotic work capacity from Table that the robotic sorting capacity is 75 packages/hour or 48 seconds/package, the moderate and longest completion time is used to forecast future conditions. For the calculation of output based on operating hours, it is assumed that each work cycle (shift) takes 6 minutes for other processes such as opening bags, sticking labels and others. If it is predicted that there will be 1,000,000 packages in the future, then to calculate the number of robots that must be used is: 1,000,000/output of 1 robot per shift, then to calculate the robot requirements (longest sorting speed condition) with 6x shifts, 1,000,000/6 x 129 = 1291 robots. If the partnership scenario with e-commerce or socio commerce is carried out, then the procurement of robots must be increased in order to handle the increase in production volume.

CONCLUSIONS AND RECOMMENDATIONS

Based on the description of the previous chapters, the author outlines the following conclusions:

1. The factors that cause inefficiency in the Supply Chain process of shipment posts and how to improve them have been successfully resolved by transforming practically digitization and automation in the form of implementing mechanization of Mega Bot robotic sorting machines and Business Process Re-Engineering which has a positive and significant effect on the company profile, namely a decrease in LDR performance from 6% to 1% and an increase in customer confidence as evidenced by the increase in the number of production of Shopee-Tokopedia Marketplace shipments in the period 2023-2024 by 400%.
2. After re-engineering the business process with the use of 40 robotic megabot sorting machines, it is proven that there has been a significant improvement and increase, namely:
   - 181% increase in sorting speed
   - Sort accuracy by 42%
   - Human Resource Utilization by 167%
   - Decrease in sorting costs by 62%
3. Recommendations to the management of PT Pos Indonesia (Persero) is that the sorting process carried out using robotic megabots is appropriate because it can have a significant impact on effectiveness and efficiency which provides added value to business process improvements. Among them, there is an increase in sorting speed, accuracy of sorting results and improving the Company's reputation in the eyes of service user customers, partners and the government as shareholders.
4. The optimal sorting activity that can be carried out in the event of an increase in production volume from the Shopee and Tokopedia marketplaces of 1,000,000 shipment transactions, using the pessimistic / longest simulation, Pos Indonesia requires 1,291 robot megabots (6x sorting cycles) and using the optimistic / fastest simulation, Pos Indonesia requires 645 robot megabots (12x sorting cycles) to be able to cope with processing shipments in accordance with the established SLA.

Recommendations :

Recommendations for pt pos Indonesia

a. PT Pos Indonesia needs to expand the distribution of the use of robotic sorting machines so that the effectiveness of efficiency work can also be obtained in other offices, not only in the Surabaya Postal Processing Center but in all Postal Processing Centers in Indonesia.
b. Business process Re-Engineering after the implementation of robotic in SPP Surabaya should continue to be carried out and developed not only in Surabaya but throughout East Java, namely in all offices in the Surabaya Regional 5 region.
c. Immediately prepare experts who will oversee the transformation process of digitization and automation in a sustainable / continuous improvement.

FURTHER STUDY

a. Expanding the scope of research from collecting to delivery
b. It is hoped that there will be research related to the impact of renewable technology for employees at PT Pos Indonesia.

ACKNOWLEDGMENT

The author would like to thank those who have helped in the preparation of this thesis, especially to the late parents, who always supported and motivated the author before he died and hopefully mama and daddy are happy there. especially to my dear wife Sri Listiani, SE, my two best sons Bramantya Rabbani and Muhammad Evan Pradipa who always provide their own enthusiasm/motivation in completing this thesis.

REFERENCES

23-2017 Jurnal Sinta 3 Minimasi Waste dan Lead Time dengan pendekatan Lean Manufacturing. (n.d.-a).

Aprilitasari, D., Nuryasin, I., & Rahmayanti, V. (2020a). Analisa Rekayasa Ulang Proses Bisnis Pada UD. Top Stiker. *REPOSITOR*, *2*(10), 1309–1320.

Day, C. P. (2018). Robotics in Industry—Their Role in Intelligent Manufacturing. In *Engineering* (Vol. 4, Issue 4, pp. 440–445). Elsevier Ltd. https://doi.org/10.1016/j.eng.2018.07.012

Eriyadi, M., & Fauzian, I. F. (2019). Desain Prototipe Mesin Sortir Barang Otomatis. *JTERA (Jurnal Teknologi Rekayasa)*, *4*(2), 147. https://doi.org/10.31544/jtera.v4.i2.2019.147-156

Febrian[1], A. (2023a). *Penerapan Lean Manufacturing dengan Metode Value Stream Mapping untuk Mengurangi Waste* (Vol. 4, Issue 1). https://jise-upiyptk.org/ojs

Fernando, D. (2019a). STUDI LITERATUR: ROBOTIC PROCESS AUTOMATION. *Sistem Informasi |*, *6*(1), 6–11.

Gantini, T., & Wijaya, Y. K. (2021). Rekayasa Proses Bisnis Layanan Pengiriman Paket. *Jurnal Teknik Informatika Dan Sistem Informasi*, *7*(2). https://doi.org/10.28932/jutisi.v7i2.3485

Imaroh, T. S., Widiyani, K., & Muttaqien, F. (2023). Value Chain and Supply Chain Management of Products from Women Farmer Groups in South Tangerang. *Wiga : Jurnal Penelitian Ilmu Ekonomi*, *13*(2), 190–203. https://doi.org/10.30741/wiga.v13i2.1088

Jamaludin, M. (2022). ANALISIS PERENCANAAN SUPPLY CHAIN MANAGEMENT (SCM) PADA PT. XYZ BANDUNG JAWA BARAT. *Jurnal Ilmu Administrasi*, *13*(2).

Morlock, F., & Meier, H. (2015). Service Value Stream Mapping in industrial product-service system Performance Management. *Procedia CIRP*, *30*, 457–461. https://doi.org/10.1016/j.procir.2015.02.128

Novian, C., Idah, Y. M., & Rifai, Z. (2022a). PEMODELAN PROSES BISNIS PENGADAAN BARANG (STOK) MENGGUNAKAN PENDEKATAN BUSINESS PROCESS MODELLING NOTATION (BPMN) (Studi Kasus: SHM Motor Purwokerto). In *Journal of Information System Management (JOISM) e-ISSN* (Vol. 3, Issue 2).

Nurma Heitasari, D., Warcono Adi, T., Kurniati, U., Logistik Migas, P., & Energi dan Mineral Akamigas, P. (n.d.). *OPTIMALISASI WAREHOUSING OPERATION DENGAN METODE DISCRETE EVENT SIMULATION PADA THIRD PARTY LOGISTICS COMPANY*.

Primandaru, S. (2019). DELIVERY PERFORMANCE IMPROVEMENT USING SIX SIGMA METHOD: A CASE STUDY AT FMC AGRICULTURAL MANUFACTURING. *Jurnal Sosial Humaniora (JSH) 2019*, *11*(1). http://creativecommons.org/licenses/by/4.0/

Prof. Richardus Eko Indrajit & Drs Djokopranoto. (2016). *Business Process Reengineering* (1st ed., Vol. 19). Bunga Rampai.

Santos, F., Pereira, R., & Vasconcelos, J. B. (2020). Toward robotic process automation implementation: an end-to-end perspective. *Business Process Management Journal*, *26*(2), 405–420. https://doi.org/10.1108/BPMJ-12-2018-0380

Teori Pendukung Reengineering Business Process. (n.d.).

Tiamaz, Y., Lahboube, F., & Souissi, N. (n.d.). *A Business Process Improvement Method*.