Packaged Juice Warehouse Operations Improvement using Business Process Reengineering Approach

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Abstract

Indonesia's packaged juice sector has a large market and contributes to the country's GDP. It is necessary to have a supply chain that responds to high customer demand to meet these needs. The warehouse acts as a storage and a source of information on the availability of goods to meet consumer demand, giving a significant impact on overall business process operations. There are still challenges in the warehouse that might lower warehouse operations' efficiency and make them less responsive to customer needs. This study aims to design improvements of the warehousing operations in the packaged juice industry through a Business Process Reengineering (BPR) approach by utilizing the Internet of Things (IoT) technology to improve time efficiency. This research presents 4 process improvement scenarios for packaged juice warehouses, with varied handling processing times for each scenario. Scenario 4 which uses automated inventory system using RFID, handheld mobile computers, and automated picking direction using voice which have the highest time efficiency, namely for raw material warehouses, inbound (8%), outbound (25%), and stocktake (35%) and finished goods warehouse, for inbound (3%), outbound (45%), and stocktake (25%).

Keywords
Packaged Juice, Warehouse, Business Process Reengineering, Internet of Things (IoT)

1. Introduction
The packaged juice industry in Indonesia has a large market and adds to the country's GDP. Indonesia's revenue from the fruit juice industry was US$696 million in 2021, with annual growth of 7.08 percent predicted until 2026 (Statista, 2021). During the pandemic COVID-19, consumption of fruit juice is increasing due to the need from the community to boost immunity and body fitness by increasing daily nutritional intake. Fruit juice can keep the body healthy with its fruit content rich in vitamins, minerals, and fiber. In addition to the pandemic COVID-19 period, in the future, consumption of fruit juices will also increase, looking at the global fruit juice market, which is expecting to reach 50.6 billion liters in volume in 2024 and $90 billion in 2025.

This industry has a lot of potential because of the growing customer interest and the extensive local and global market for packaged juice drinks. The warehouse plays an essential function in satisfying market demand by protecting supply and demand fluctuations (Gu et al., 2007). Warehouses play a significant role in the supply chain as a storage location, a source of information for other divisions, and a fulfillment location for consumer requests (Purnomo, 2018). As a result, the warehouse plays a critical role in anticipating and fulfilling many customer demands. The company's operations will be impacted by rising the market demand in the packaged juice business. The production process will speed up, affecting the warehouse's ability to supply raw materials. Warehouses must also increase their efficiency to meet market demand with high-quality, relevant merchandise.

The manual warehouse operations might result in low warehouse operational efficiency and a lack of responsiveness to customer demand (Lee *et al.*, 2018). As a result, the warehouse's role as a fulfillment center for consumer demand will be decreased. In addition, warehouse management faces inventory accuracy, process management, space utilization, and retrieval optimization (Richards, 2014). Other problems that frequently arise in warehouses, according to Zhang (2021), include loss of goods, difficulty in selecting storage areas due to humans, or other reasons. The time spent searching for products and engaging in other non-value-added activities can increase processing a customer's order. According to Pereira (2019), warehouses require less processing time to reduce errors and fewer trained workers. So, the operational warehouse process must be improved to deliver better performance.

1.1 Objectives
This research aims to optimize the packaged juice warehouse process by combining IoT technology with a business process reengineering (BPR) methodology to reduce customer order processing time. This study used direct observation and in-depth interviews in packaged juice warehouses to determine each process's current process flow and processing time.

2. Literature Review
2.1 Warehouse
The warehouse is part of the company's logistics operation responsible for the storage area and inventory handling, starting with the receipt of goods from the producer and finishing with the point of consumption. (Alumbugu et al., 2021). The warehouse serves as a buffer against market volatility and a safeguard against demand uncertainty and lead times and assists in providing a diverse product selection to clients (Pereira *et al.*, 2019). Due to the complexness of multiple customer demands, the requirements for real-time details, and data accurateness, the role of today's warehouse has evolved considerably (Lee *et al.*, 2018).

2.2 Business Process Reengineering (BPR)
Business Process Reengineering implies a fundamental rethinking and radical redesigning of business processes to achieve higher performance, such as quality, cost, speed, and service (Hammer, M., & Champy, 1994). BPR is a business management technique that focuses on evaluating and reconstructing a company's material and information workflows and processes (Azzahra and Dachyar, 2021). According to this technique, should replace the used system with a new system that is more effective and innovative (Dachyar and Christy, 2014). The concept of BPR is also one of the critical factors in the development that focuses on the rapid and fundamental redesign of strategic administration processes by providing added value (Alhawamdeh, 2021). BPR does not accept gradual adjustments, preferring to deal with fundamental changes in technology and economics (Keramati., 2011). BPR has proven to be successful in the food industry, saving up to 48% of time for all business operations (Pratiwi and Dachyar, 2020). BPR was also applied to warehouse processes and resulted in a 46% reduction in lead time (Fera *et al.*, 2017).

2.3 Business Process Reengineering (BPR) and Information Technology (IT)
Since the beginning, business process reengineering has had a close relationship with information technology. Processes, which are at the base of reengineering, can be redesigned due to technological advances. Both have a symbiotic relationship in which information technology produces nothing without reengineering, and a small amount of reengineering can be done without information technology (Hammer and Champy, 2001). So, both are key to thinking about each other. Information technology can be used in BPR because of its ability to overcome time and distance constraints. In exchanging company goals, IT can reduce time and improve accuracy. Using the BPR method and integration with RFID technology in spare parts warehouse saves time and reduces operational costs by 17.8% (Bevilacqua et al., 2011). Several companies combine BPR and IT to reduce costs and cycle times while also improving quality, production volume, and speed of operations, including: Wal-Mart reduced restocking time from six weeks to 36 hours; Honeywall reduced defect rate by 70%, consumer rejection by 57 percent, cycle time by 72 percent, investment by 46 percent, and customer waiting time by 70%, etc (Bhaskar, 2015).

2.4 Internet of Things
The Internet of Things (IoT) is a technology that connects or captures all device information or machine and sends it over the internet, regardless of the platform, to any destination (Banerjee, 2019). IoT refers to a network of interconnected objects with a unique identity and communication using standard protocols (Dachyar et al., 2019). The internet of things (IoT) was designed to allow devices to connect over the internet (Jinil Persis et al., 2021). The Internet of Things (IoT) provides for a more direct connection to the real world with computer-based and digital systems, resulting in increased accuracy, efficiency, and economic advantages and increased automation, and less human intervention. (Janiesch et al., 2017). By using IoT, users can monitor field conditions from afar without having to make direct contact. This can help reduce problems that are deemed unsolvable due to a lack of knowledge, particularly in the supply chain framework (Banerjee, 2019).

2.4.1 Automated Inventory System
An automated inventory system is a technology-based system used to control products and sales within an organization. This system increases operational efficiency, replacing manual efforts with automation with reduced costs (David, 2019).

2.4.1.1 Barcode

A 1-D barcode is a series of vertical bars of varying widths, representing each number from zero to nine with a unique bar pattern that a laser scanner can read (Sivakami, 2018). The QR Code (Quick Response Code) is a matrix barcode or two-dimensional barcode that encodes data from up to down and left to the right. As a 2-D barcode, QR Code can overcome 1-D barcode flaws such as low and inadequate information density and capability. (Thanapal, Prabhu and Jakhar, 2017). QR-Code can also read codes more accurately than other 1-D and 2-D codes (Lotlikar et al., 2013). The order picking process can be sped up by 8,329 minutes by using QR codes on a mobile device (Pipatprapa, 2019).

2.4.1.2 RFID

RFID (Radio Frequency Identification) is a technique that enables goods to be automatically identified using tags on each item that are situated at a reading distance from the device antenna. RFID helps automatically identify whatever is attached to the RFID tag (Gubbi et al., 2013). Various types of information about the environment or monitoring object can be monitored, sensed, and collected in network coverage in real-time by sensors (Liu, Li and Jiang, 2014). RFID technology's complexity brings various benefits to supply chain management, including product identification, real-time data, and communication convenience (Bevilacqua et.al., 2011)

2.4.2 Automated Picking Direction by Voice

Manufacturing and distribution industries that require a lot of labor have significantly benefited from voice technology. Workers can be safer on the job, work more precisely, and focus more on processes due to controlling speech (Dujmešić et al., 2018).

3. Methodology

This research begins by conducting a literature study to determine the background, problems, and research objectives. Then follow the BPR approach, which is divided into three steps. The first step is to conduct in-depth observations and interviews with experts to obtain and understand the current process of the packaged juice warehouse. After that, using the iGrafx application, the current process was modeled and simulated. Then the second step reviewed the result to establish the current model's issues and limitations and conducted a customer interview to get the voice of the customer (VOC). Current concerns are coupled with the VOC to generate solution recommendations in the last stage. The application solution is then modeled as a to-be model and simulated using iGrafx software. The simulation results compare the solutions that provide the highest time efficiency.

4. Data Collection

Research was conducted in an Indonesian warehouse at a packaged juice company. The data is gathered through direct observations and measurements each time the process is carried out and interviews with warehouse workers to map existing processes to create business process modeling. By factoring in the allowance, the present processing time data is transformed to standard time and then entered into the model. The packaged juice warehouse is separated into raw material and finished goods warehouses. The warehouse's three core business processes are inbound, outbound, and stock-taking. Table 1 shows the duration of each process.

Table 1.Packaged Juice Warehouse Process Time

No	Process	Standard Time (minutes)	No	Process	Standard Time (minutes)
1	Receive delivery order from driver	7,7	35	Record the number of returns	3,8
2	Provide D.O. to purchasing staff	17,6	36	Walk to the office	18,3
3	Give to warehouse admin	5,3	37	Checking issue request documents	9,4
4	Checking delivery order	4,1	38	Create a POD	16
5	Inform the operator	6,6	39	Giving POD to the production team	2,3
6	Waiting for operator for unloading	17,6	40	Provide information to admin	3,4
7a	Dropping the sample from the car	3,5	41	Checking POD	4,7
7b	Check sample goods	15,7	42	Stock update to the system	26,9
7c	Pick up pallets	22,3	43	Saving product	228

7d	Unloading goods from the car	36,7	44	Moving products to cold storage	38,9
7e	Counting the number of items	11,3	45	Arrange products in cold storage	9,6
7f	Write down the date of receipt goods	1,9	46	Receive close order information	0,5
7g	Reject item	1,4	47	Fetch list products from the system	6,9
8	Inform the warehouse admin	6,6	48	Print sales list per product	0,8
9	Making proof of delivery (POD)	11,7	49a	Walk to the warehouse	1,7
10	Giving POD to driver	6,3	49b	Check the number of products	41,1
11	Operators move goods to warehouse	37,1	49c	Write the expired date	52,3
12	Operator arranges goods	53,7	50	Moving products to cold storage	3,4
13	Update to system	8,1	51	Inform the logistics team	0,6
14	Receive issue request	3,3	52a	Receive invoices from logistics	2,7
15	Checking the Issue request form	6,0	52b	Reading invoices	55,1
No	Process	Standard Time (minutes)	No	Process	Standard Time (minutes)
16	Inform the operator	8,7	52c	Prepare products	247,2
17	Waiting for operator	27,6	52d	Put out product from cold storage	32,1
18	Give the issue request form to the operator	3,8	53	Check product quantity	44,5
19	Check the availability of goods	17,3	54	Loading the product into the car	60,6
20	Prepare goods	68,9	55	Walk to the office	5520,0
21	Deliver goods	1276,0	56	Put the invoice to the admin desk	0,4
22	Create a POD	21,3	57	Sorting invoices VT, NV,NVB	11,1
23	Inform the warehouse admin	4,6	58	Update data to the system	37,7
24	Update data to the system	10,7	59	Fetch the final inventory list from system	3,8
25	Fetch final inventory list from system	2,4	60	Print the final inventory list	1,6
26	Print the final inventory list	0,8	61a	Walk to cold storage	1,8
27	Walk to the warehouse	1,0	61b	Counting finished goods inventory in cold storage	19,1
28	Calculating raw material inventory	31,2	61c	Matching cold storage stock inventory with system	4,8
29	Matching stock inventory with system	7,7	61d	Walk to the warehouse	1,7
30	Checking data on the system	26,7	61e	Counting finished goods inventory in the warehouse	17,2
31	Receive products from production	4,4	61f	Record warehouse stock inventory	1,3
32	Checking the product	16,8	61g	Walk to the office	1,5
33	Record the number of products	4,5	62	Stock checking with system	24,1
34	Transferring returned goods	21,3			

5.Results and Discussion

5.1 Packaged Juice Warehouse As-Is Process

The packaged juice company where did the research has two warehouses, one for raw materials and the other for finsihed goods. The raw material warehouse serves as a source of raw materials for the production division. The finished goods warehouse is responsible for filling customer orders. Inbound, outbound, and stock-taking processes are three basic processes. The company currently uses an ERP system to make it easier to offer information on the availability of commodities and products in the warehouse. At the warehouse, the operator is in charge of receiving and releasing commodities. The warehouse administrator is entering the receiving and releasing commodities data into the ERP system.

Receiving products from the supplier begins the inbound process at the raw material warehouse. After that, the operator calculates and reports to the admin, who puts the information into the ERP system. Then the operators load the goods into the warehouse for storage. The outbound process begins when the production division requests goods and the operator prepares the required goods using the issue request form. After the delivery of the goods, the operator will notify the administrator, who will update the data in the system. Administrators and operators conduct the stock-taking process, checking the number of products in the system to those in the warehouse.

The inbound process for finished goods warehouses begins with an incoming product from the production division. The operator will inspect, calculate, and inspect the incoming product by the products request form, returns form, and additional requests form. The operator will notify the admin, who will input the data into the ERP system. The outbound process begins after receiving close order information from the order tracking division. For the outbound process, the operator will check the order list data into the ERP system and then check the amount of stock in cold storage. The operator will take the product from the warehouse if the number of goods in cold storage is low. The loading process starts when the product is by the order list from the order tracker. After the loading process, the operator will submit an invoice to the admin office, which will use to input the product data. If the data has been entered, the admin will do stock-taking to ensure that the data in the system and warehouse is correct.

The packaged juice warehousing process used BPMN (Business Process Model Notation) to illustrate the entire warehouse process. The packaged juice warehouse model can be seen in Figure 1.

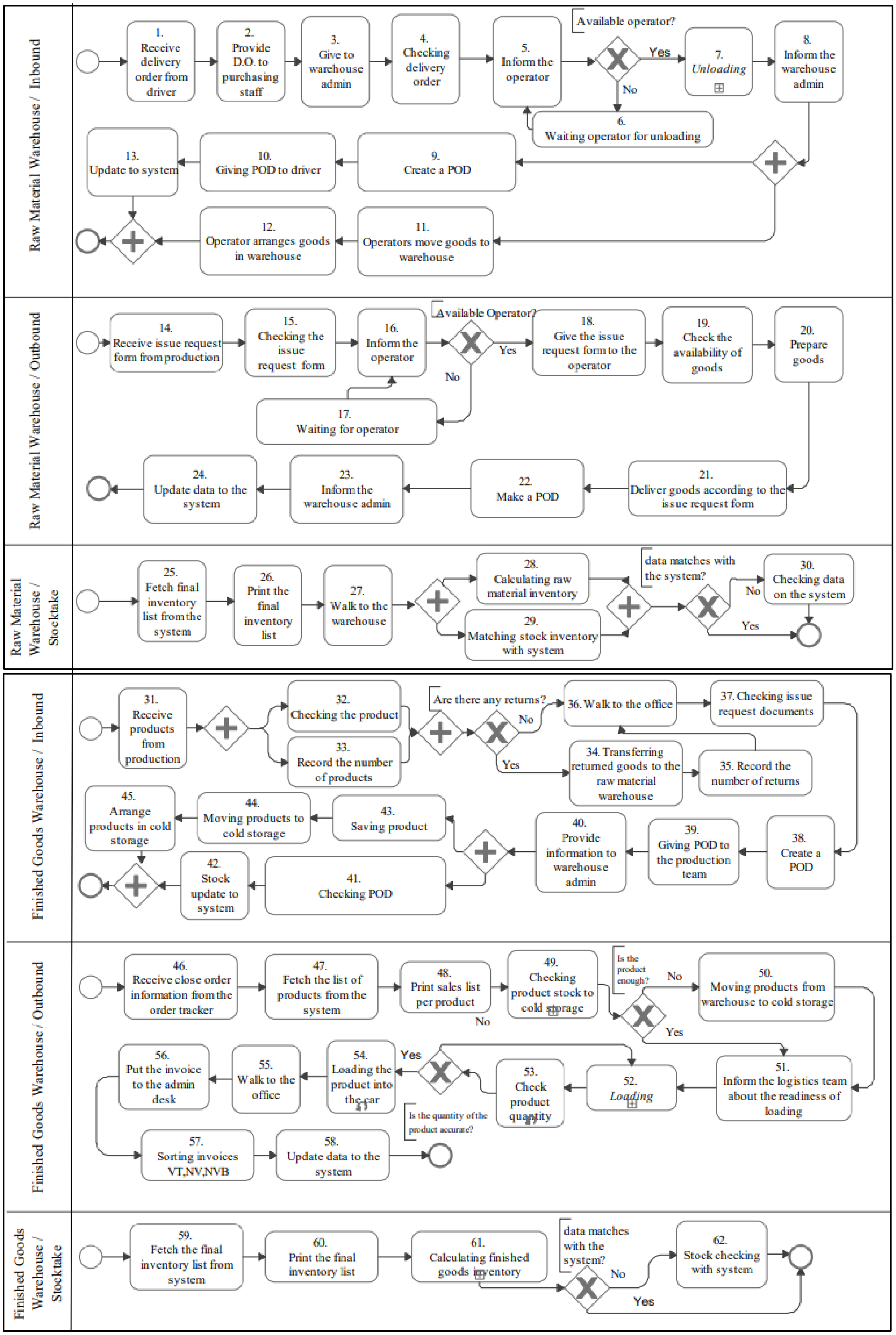

Figure 1. Packaged Juice Warehouse As-Is Process

There are four subprocesses for the as-is process shown in Figure 2. There is a procedure of inspecting samples of the items received during the unloading sub-process. If many products do not comply with the standards, they will return the goods to the supplier. For the sub process checking product stock to cold storage, the operator also manually writes the expirated date per item while checking. The operator then does the sub-process loading by reading the order invoice and taking the products.

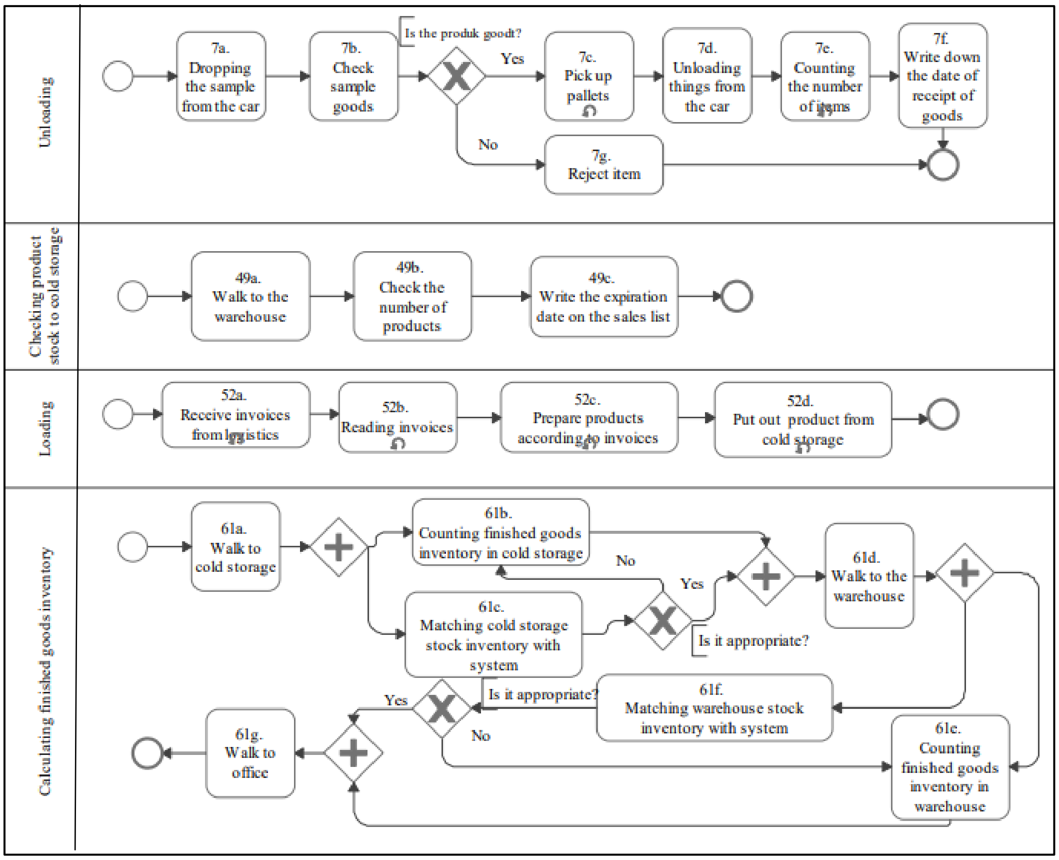

Figure 2. Packaged Juice Warehouse As-Is Sub Process

Table 2 shows the findings of the as-is model on BPMN iGrafx, which shows the total process time (cycle time) for each process, including work time and the waiting time.

Table 2. Packaged Juice Warehouse As-Is Process Simulation Result

Transactions Statistics (Hours)	Avg Cycle	Avg Work	Avg Waiting
Raw Material Warehouse / Inbound	3,81	3,68	0,13
Raw Material Warehouse / Outbound	2,69	2,69	0,00
Raw Material Warehouse / Stocktake	1,17	1,04	0,13
Finished Good Warehouse / Inbound	6,22	6,22	0,00
Finished Good Warehouse / Outbound	9,32	9,32	0,00
Finished Good Warehouse / Stocktake	1,28	1,18	0,10

5.2 Analysis of As-Is Process and Designing Solutions

The As-Is model's simulation findings, which include identifying procedures that take a long time and existing problems found through expert interviews, improve the process. At the warehouse, several concerns existed found, including:

- Data is still manually entered into the system.
- Information is still reported on paper, which is frequently lost or damaged, causing delays in sending information and updating data in the system.

- Because the system's data is inaccurate, stock checks are done manually at the warehouse then instead of checking stock in the system, extending processing time.
- Error picking up the product to be sent to the customer.

Furthermore, the voice of customers (VOC) approach is used to analyze the packed juice warehouse process. Then, by investigating the relationship between issues and VOC's final output (goal), solutions were developed (seen in Table 3).

Table 3. Packaged Juice Warehouse Goal-Problem-Solution

Goal	Problem	Solution	BPR Best Practice
Efficiency	Inventory recording is still done manually and has repeated frequencies.	Using process automation with technology for direct inputting data.	Process elimination and technology integration
	Repeated product retrieval process due to errors at the time of retrieval	Using technology that can assist operators in reducing errors in the process of picking goods.	
Real-Time	Products in and out of goods from warehouses are undetectable	Presents the data information in real-time on the system using automation of incoming and outgoing product information processes	Integration of Technology
Accuracy	Order pick-up error and the number of goods in the system and warehouse is not appropriate	Using process automation with technology that has automatic data recording and storage features and with warning features for mismatches in the collection of goods	Process elimination and technologyintegration
Completeness	Information about the product on the system is incomplete and still manually searched in paper documents	Present complete product information on the system	Integration of Technology
Integration	Access to information related to the number and location of goods stored in the warehouse is still done manually (using phone, whatsapp, or paper) so that it is less effective.	Present information that is easily accessible to various parties concerned	Process elimination and technology integration

5.3 Packaged Juice Warehous To-Be Process

Based on the classification of previous solutions, the proposed improvement in packaged juice warehousing is separated into four scenarios (seen in Table 4). In the scenario, the automatic inventory system is compared to the use of QR-Code and RFID tags. Handheld mobile computers give operators information more accessible, and automated picking direction by voice helps eliminate picking errors.

Table 4. Warehouse Operational Improvement Scenario

Scenario	Automated Inventory System Using QR-Code	Automated Inventory System Using RFID	Handheld Mobile Computer	Automated Picking Direction by Voice
S1	✓			
S2	✓		✓	
S3		✓	✓	
S4		✓	✓	✓

In scenario 1, an automated inventory system using QR-Code is implemented to speed up updating data in the system. This system is installed in both the raw material and finished goods warehouses. This scenario needs a QR-Code scanner that will read all of the data on each arriving and exiting item's QR-Code label and automatically update the data in the system, eliminating the requirement for the operator to update data in the system manually. By removing manual and repetitive operations from various processes, this system will eliminate the possibility of receiving and outgoing goods information not being sent. It will also cut down on the time it takes to perform inbound and outbound operations.

Process improvement in scenario 2 is accomplished using an automated inventory system using QR-Code and a handheld mobile computer. With these two technologies in place, real-time updates on incoming and outgoing products will be automatically entered into the system. In addition, using a handheld mobile computer used by operators in the warehouse can facilitate communication with various relevant stakeholders, and operators can also have direct access to the system.

The proposed scenario 3 design implements an inventory management system using Radio Frequency Identification (RFID) and a handheld mobile computer. This scenario compares with the use of QR-Code, where RFID has an advantage in terms of time for the tag reading process. Radio Frequency Identification (RFID) implementation consists of three things: RFID Tag, RFID Reader, and Application Software. This scenario uses two RFID Readers, namely RFID Gate Readers and Handheld RFID Scanners. There must also be essential data about the product in the RFID Tag.

The proposed improvement in scenario 4 is implementing an automated inventory system using RFID, automated picking direction by voice, and a handheld mobile computer. Pick by voice technology is utilized to pick up goods at the finished goods warehouse in this scenario, similar to scenario 3. A pick by voice technology influences the operator's loading process. Following the voice's instructions is how the picking products are processed on the pick by the voice system.. This approach has the greatest number of benefits and is the most efficient.

The proposed to-be process model's simulation results are compared to the as-is model's results to show precise time changes in each scenario (see Table 5).

Table 5. Results of As-is and To-be Model

Process	As-is (hour)	S1 (hour)	S2 (hour)	S3 (hour)	S4 (hour)
Raw Material Warehouse / Inbound	3,81	3,70	3,59	3,50	3,50
Raw Material Warehouse / Outbound	2,69	2,43	2,08	2,01	2,01
Raw Material Warehouse / Stocktake	1,17	1,17	1,11	0,76	0,76
Finished Good Warehouse / Inbound	6,22	6,14	6,07	6,04	6,04
Finished Good Warehouse / Outbound	9,32	7,42	6,15	5,97	5,11
Finished Good Warehouse / Stocktake	1,28	1,28	1,19	0,96	0,96

To determine the process efficiency of reducing the average cycle time of each scenario, the outcomes of each proposed scenario are compared to the As-Is model. Table 6 shows the process efficiency comparisons between scenarios 1, 2, 3, and 4.

Table 6. Efficiency Comparison Between To-Be Model

Process	S1	S2	S3	S4
Raw Material Warehouse / Inbound	3%	6%	8%	8%
Raw Material Warehouse / Outbound	10%	22%	25%	25%
Raw Material Warehouse / Stocktake	0%	5%	35%	35%
Finished Good Warehouse / Inbound	1%	2%	3%	3%
Finished Good Warehouse / Outbound	20%	34%	36%	45%
Finished Good Warehouse / Stocktake	0%	7%	25%	25%

Scenario 4 gives most efficiency gains, according to simulation results. Scenario 4 combines an automated inventory system using RFID, handheld mobile computers, and automated picking direction by voice. Combining these technology results in automation data input to the system ERP and information sent to employees in real-time and accurately. Also, can reduce human error in counting and picking products.

The process changes in scenario four can be seen in Figure 3. Several BPR best practices are used in this scenario, including process elimination, process addition, and technology integration (Fosso Wamba and Chatfield, 2010; Busato *et al.*, 2013). Two lines indicate that the application of technology has resulted in a time reduction in specific processes. While, the three lines show that there is a new process in place of the manual process.

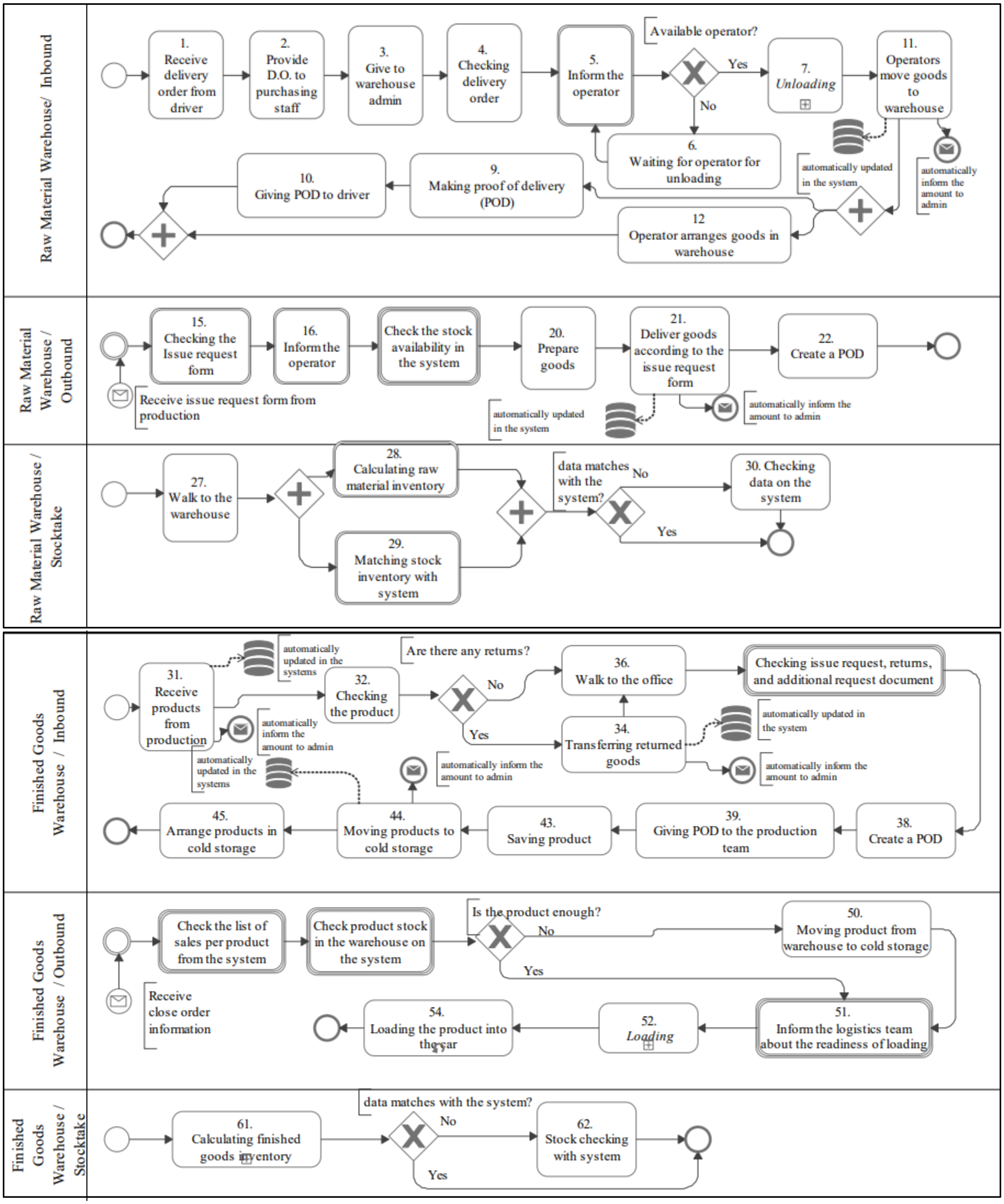

Figure 3. Packaged Juice Warehouse 4th Scenario Process

Figure 4 shows a sub-process model to-be. The number of sub-processes in the to-be model has been reduced. The stock to cold storage sub-process has been removed because, with the execution of scenario 4, it can do the stock inspection on a real-time and accurate system.

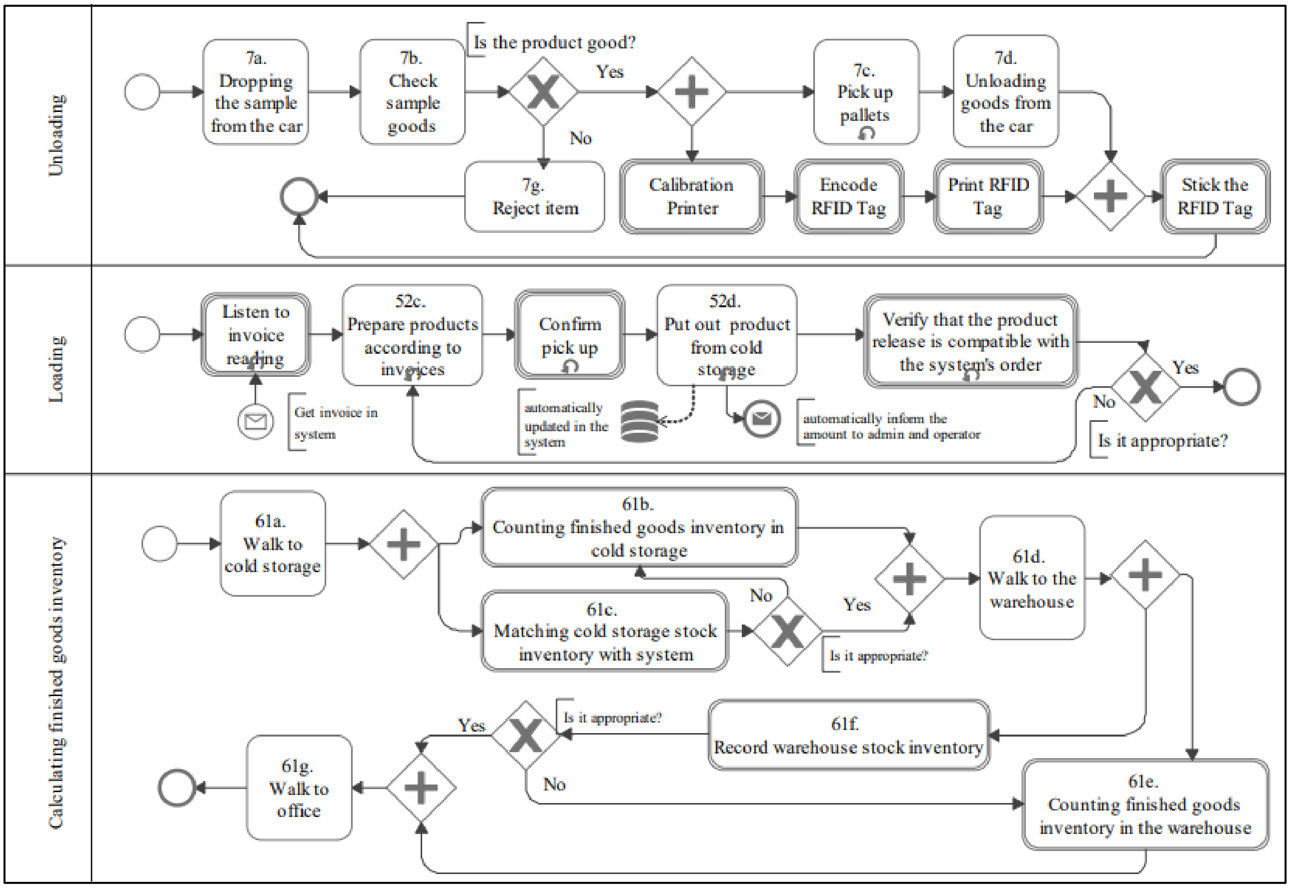

Figure 4. Packaged Juice Warehouse 4th Scenario Sub Process

The capabilities of human resources on the warehouse or its personnel must also be considered when implementing this scenario. In this circumstance, there must be training for the use of technology. The system still employs the default language, especially for automated picking direction by voice technologies. As a result, language differences must be handled through training.

6. Conclusion

This research proposes using the BPR approach in conjunction with the internet of things to improve the packaged juice warehouse process. There are four scenarios for improving the packaged juice warehouse's operational process, including integrating technology and business process elimination.. In scenario 1, an automated inventory system using QR codes is used. Scenario 2 implements an automated inventory system using QR-codes and a handheld mobile computer. Scenario 3 uses a handheld mobile computer and automated inventory system using RFID. Scenario 4 involves using an automatic inventory system using RFID, a handheld mobile computer, and automated picking direction by voice. Scenario 4 have the highest time efficiency, namely for raw material warehouses, inbound (8%), outbound (25%), and stocktake (35%) and finished goods warehouse, for inbound (3%), outbound (45%), and stocktake (25%).

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