Improving the efficiency of the return process: The case of JD Logistics warehouse

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Preface

Dear reader,

In front of you lies my bachelor thesis assignment “Improving the efficiency of the return process: The case of JD Logistics warehouse”, this bachelor thesis is written for the completion of the bachelor’s degree in Industrial Engineering and Management at the University of Twente. The research is conducted at the warehouse of the company JD Logistics located in Venray. This thesis aims to improve the efficiency of the return process by optimizing the operation process and improving the resource management strategy of the operation team.

First, I would like to thank all employees at JD Logistics for their welcome and help to me as an intern. I can sense a great learning atmosphere when I gain knowledge not only from the Return department but also from other fields. I want to thank Hao Huang in particular who is my supervisor at the company during my research period. Thanks to his patience and guidance so that I can gain insights into my study. I also want to thank my buddy at the same host company Su Tong, with his sharing of the experience and effective communication, my research becomes more valuable.

I also want to thank Devrim Murat Yazan and Leo van der Wegen, my supervisors from the University of Twente. I am grateful for their time and efforts to provide me with feedback and guidance. The feedback truly helped me to work towards a formal bachelor thesis, the communication was also sufficient and well-structured.

Enjoy reading!

Kind regards,

Chenyang Wang
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Management summary

Problem definition

As an operation intern at the Return department, I am responsible for monitoring the daily performance and communicating with leaders in the warehouse to make resource adjustments. During the internship, JD Logistics on average received 20 email complaints when customers could not receive their refund in a short valid time, and this huge number had a negative effect on customer satisfaction. Furthermore, the company internally stated that they had a low margin when considerable working hours need to be paid to operators. The action problem is revealed by the company that JD Logistics is now having low efficiency of the return process in the warehouse. Two potential core problems are defined: first, the Return department has poor resource management strategies which leads to both inaccurate return order forecasts and inappropriate labor arrangements. They will further affect operators' performance and then reflect on the low return efficiency. Second, the operation process within the return system is complicated. Numerous user-unfriendly steps waste operators' time and hence lead to low return efficiency. As a result, the main research question is defined as: How can operation process optimization and resource management strategy improve the return process efficiency? To answer this question, an investigation into the operation process and resource management is conducted as perspectives of improving the return process performance.

Research methods

The Managerial Problem-Solving Method (MPSM) is the main methodology for this research. The first step is to analyze the current situation. In this phase, the current situation of the company is analyzed by observations of the return processes, communication with employees at the Return department and operators in the warehouse. Data analysis of operators' performance is also conducted. By implementing the problem cluster, the potential core problems can be identified. Then literature review is conducted to perform the historical study on organization efficiency and select my theoretical perspective. Business Process Management is selected as my theoretical perspective to gain insights into problem-solving. To operationalize the variables within the research, KPIs need to be defined and selected. They include mobility, of operators, effective working hours, productivity per task, overall productivity and customer satisfaction. The inspiration for new solutions can be obtained through the literature review and brainstorming session, existing solutions are supported by literature whereas new solutions are generated through a brainstorming group. Solutions are based on two different perspectives: operation process and resource management strategy.

Operation process aspect:

- Cancel put-away containers
- Advance the refund point
- Transfer putaway task to AGV zone
- Change the current pre-inspection information input method
    - Partial scan method
    - Full scan method

Resource management aspect:

- Control operators' mobility in the warehouse
- Forecast the return order numbers
- Arrange resource allocation reasonably

Due to the time limit, only operation process concerned solutions are selected to be implemented. JD Logistics also agrees that the operation process has a higher priority than resource management in the current circumstance and optimizing the return process is imminent for the company. However, the historical performance data also provide information for resource management and through systematic statistics of data, recommendations based on resource management are made to JD Logistics based on the As-Is situation.

Results

Systematic statistics of data exported from WMS have to be analyzed through MS Excel functions. Evaluation of performance based on KPIs will result from the observed data and in form of graphs to support decision-making objectives. By applying the VLOOKUP to the data used in the WMS, the objectives on the respective level will be visualized within MS Excel. Based on the graphs, the company gains insights into the relationships of KPIs and makes decisions.

The results show that by canceling put-away containers, the productivity at the pre-inspection increases from 11 orders per hour per operator to 15 orders per hour per operator. Overall return process productivity increase by 38.18% from 44.87 to 62 orders per operator per day. The refund point advance solution increases customer satisfaction by 27.5%. The full scan method increases the pre-inspection productivity from 11 to 15 whereas the partial scan method improves the pre-inspection productivity from 11 to 17. The overall return process productivity increase by 15.9% and 21.9% respectively for these two methods. Putaway to AGV zone has a putaway task productivity improvement from 19.3 to 23.3 orders per operator per hour, the overall return process productivity increase by 5.2%.

Conclusions

JD Logistics is suggested to implement all operation process solutions in-depth in the future except for the putaway solution. In terms of the overall productivity, putaway to AGV zone has relatively small improvements compared to other operation process solutions. Therefore, the company needs to take further consideration.

In terms of resource management strategies. Maximum task mobility of two at the return process is suggested. During the investigation of the historical performance of operators, operators have the best and most stable performance if one person at most does two types of tasks at the return process. An accurate return order forecast should follow the outbound order quantity from historical days. The data-trace shows that most outbound orders arrive at the warehouse as return orders equally between 7 to 9 days after shipment. Furthermore, two types of outbound order types are recognized and their proportion of the total outbound orders can be gained. Therefore, a forecast of return order quantity to be received on day x can be estimated by historical outbound quantity back to 7 to 9 days before. The operator allocation for the return process should follow the theoretical operators needed for each task to finish the same target orders. The performance history shows when there are 1000 return orders, the closer the allocation proportion to pre-inspection: transfer: putaway = 11: 3: 6, the better efficiency the return process has.

Due to the time limit, operator performance solutions did not manage to implement, the company is advised to test the reliability and validity of resource management-related solutions as one of their further research directions.

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List of abbreviations

RMA operator: The person who is responsible for return process operating, including inspection, transfer, sealing and putaway.

FOP: Fulfillment Orchestration Platform (FOP) is the order management system for JD

WMS/ JD WMS: Warehouse Management System (WMS) is the warehouse management system for JD

PDA: Personal Digital Assistant (PDA) is the equipment used for putaway task.

RF scanner: The Radio Frequency (RF) scanner is one equipment to scan bar-code.

AGV: Automated Guided Vehicle (AGV) that is used for moving shelves that compose JD warehouse inventory.

PC: Personal computer that is used by operators in JD warehouse.

BPM: Business Process Management

BPMN: Business Process Model and Notion

MPSM: Managerial Problem-Solving Method

KPI: Key Performance Indicator

1. Introduction

In this chapter, an overview introduction of the thesis is given. Section 1.1 starts with the company background introduction to let readers know the company type and my role within it. In Section 1.2, problems are identified with the action problem and the core problem, general problems are denoted. The MPSM is applied as the problem-solving approach in Section 1.3, scope and limitations are discussed in Section 1.4. In Section 1.5, research questions are generated centered on the main research question with designs. Section 1.6 shows the deliverables to be delivered in this thesis, finally, validity and reliability are defined in Section 1.7.

1.1 Company background

JD Logistics is China's leading technology-driven supply chain solutions as well as a logistics service provider. As a spinoff, JD Logistics is the shipping and delivery arm of JD.com which is China's second-largest e-commerce company (David Wertime, 2021). JD Logistics has the vision to drive superior efficiency and sustainability for the global supply chain through technology. JD Logistics rented a warehouse from logistics real estate developer DHG in Venray in 2021, it is the first distribution center of the company in the Netherlands. Within a short period of the operation time, it accumulates partnerships with several significant retailers including Hunkemöller, Huami and Wowcher. As the biggest stakeholder, Hunkemöller outsources the e-fulfillment in the Benelux and France to JD Logistics and e-commerce orders are handled within the warehouse in Venray. The return process that will be introduced in this thesis only focuses on the return orders of Hunkemöller instead of other stakeholders.

There are currently five departments in the JD Venray warehouse, they are Inbound, Inventory, Outbound, Return and Customer Service respectively. As an operation intern, I am responsible for the Return department to monitoring and optimizing the whole return process within the warehouse.

1.2 Problem identification

1.2.1 Action problem

The action problem that now exists in JD Logistics focuses on the low efficiency of the return process. This action problem is reflected in different aspects of the warehouse. First, customer satisfaction is low when customers cannot receive their refund in a short valid time. Due to the current complex operation processes, numerous steps need to be involved to trigger the refund which makes the process dilatory. Therefore, the Customer Service department receives complaints from customers when their refund status shows unprocessed or in progress. Second, considerable working hours need to be paid to operators which brings the company a low margin. As a coherent system, the outcome of the return process also connects to the performance of other departments such as Inventory and Outbound. When costs at the Return department rise which indicates the budget for other departments may decrease to fulfill the overall warehouse operation. Third, the Return department frequently has difficulty reaching its daily target that all return orders should be finished within 24 hours from the beginning. The order backlogs between different working stations compose the main reason when return orders are waiting in progress and cannot be finished in time. As a result, the action problem negatively affects the company's operation, solving the action problem of low efficiency in the return process is prioritized and imminent.

1.2.2 Problem cluster

The current problem cluster of JD Logistics regarding the return process is shown in *Figure 1. Problem cluster*. Problems are denoted as the action problem, the general problem, the potential core problem and the core problem. Sub problems for the overarching action problems are defined and the core problem is revealed. JD Logistics has an action problem of low efficiency of the return process in the warehouse. Return efficiency is defined as the productivity of operators in terms of the overall return process. It can be measured by the number of return orders done from the first task to the final task of the return process per day per operator.

Two potential core problems are recognized. First, the Return department has poor resource management strategies which lead to both inaccurate return order forecasts and inappropriate labor arrangements. They will further affect operators' performance and then reflect on the low return efficiency. Second, the operation process within the return system is complicated. Numerous user-unfriendly steps waste operators' time and hence lead to low return efficiency.

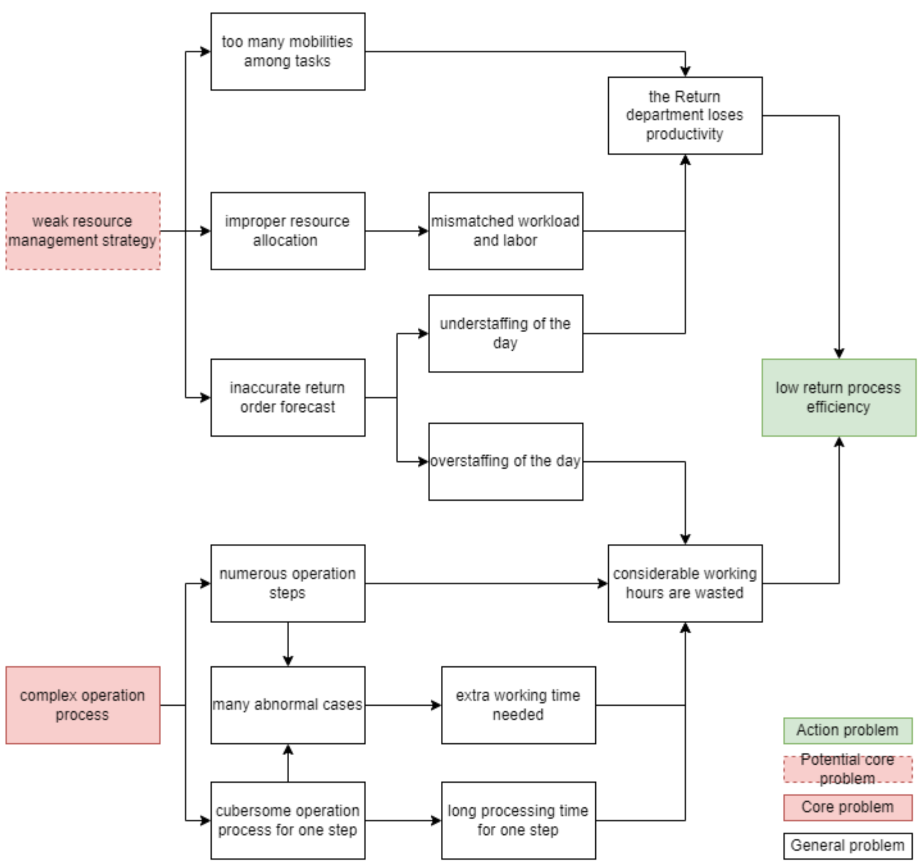

Figure 1. Problem cluster

1.2.3 Core problem

The first potential core problem is defined as a weak resource management strategy within the company. Personnel mobility can potentially be a factor that is involved in resource management strategy and influences the total return process outcome. One operator that focuses on one single job may have higher productivity than another operator that switches between three or more types of tasks. The problem now for operators is that they have over mobility among different tasks. It is a fact that rather than doing at most two types of jobs per day, operators are now operating more jobs which leads to less proficiency in specific tasks. Finally, less proficiency results in low efficiency. For instance, an operator needs to handle one thousand goods in two days for pre-inspection to become professional. Instead of doing so, the operator first finishes 200 pre-inspections and then proceeds to complete 200 putaways, at last ending up accomplishing 300 units of transfer. As a result, this operator needs five days to become an expert in the pre-inspection field in neglect of buffer time in between and proficiency rusty possibility. These extra days are regarded as an efficiency loss and hence become what we should avoid improving operators' performance. Furthermore, the return order forecast that reflects on the daily operator headcount is not precise enough. Overstaffing and understaffing happen regularly to fluctuate the productivity of the day when the return order forecast is not accurate, therefore working hours are wasted during overstaffing and the Return department cannot reach its daily goal during understaffing. Resource allocation method is improper within the Return department as well, unbalanced workload arrangement and labor allocation between stations leave backlogs for some certain tasks even they are working with full capacity. However, other stations remain unoccupied which is considered a productivity loss and finally results in low efficiency in the return process.

The operation process of the present pattern is not optimal which is the second potential problem. Operators switch from scanning to manual input frequently within the system which is time-consuming during production. From the pre-inspection perspective, operators are required to create after-sales inbound orders first and then go to the pre-inspection to complete the return orders. Inspectors literally need to open the order creation page in the system, scan the barcode, press enter, then go to the pre-inspection page and start pre-inspection. When one common repetitive job appears within a continuous operation process, it comes along with the complexity and workload pressure that finally results in low efficiency. The abnormal cases raised by complex processes are kept at a high level as well, which requires extra operators and time to handle and becomes one of the components of the costs. This great amount of working hours in total negatively contributes to the return process and leads to low process efficiency.

In this thesis, I will solve the low return process efficiency action problem by addressing both potential core problems because they are both interesting and valuable aspects to investigate for the company. Therefore, the two perspectives based on resource management strategy as well as operation process will be considered from beginning to final conclusion. However, the complex operation process becomes the core problem because it has a higher priority and importance in the research. As the infrastructural framework of the return process, the operation process provides insights into the systematic structure of the overall process guidance, whereas the resource management strategy assists the company with better performance monitor and management under the operation process framework. A well-structured operation process is a premise of conducting effective resource management strategies. JD Logistics considers the operation process improvement as the first priority and wants to optimize the operation process as an imminent task. The company thinks the optimizations in the operation process have the most potential for overall efficiency improvement. A well-designed operation process also has an enduring life cycle that can be sustainably used in the future, then adds value to the company in the long run. Furthermore, the resource management strategy should integrate with the operation process and align with it, it is not possible to implement effective strategic solutions on a business level and get promising outcomes without a predominant and reliable operation process basis. In this case, resource management strategy becomes part of process optimization and contributes to overall return process efficiency improvement. In conclusion, both potential core problems will be addressed in the thesis to solve the low return process efficiency action problem whereas the operation process becomes the core problem to focus on.

1.3 Problem-solving approach

As my research methodology, I will use the managerial problem-solving method for enhancement. The managerial problem-solving method is a roadmap on how to identify, conduct thorough research into, and lastly solve a core problem. MPSM is divided into seven phases and it is a method in which the creative and the systematic complement each other (Heerkens & van Winden, 2016). *Figure 2. Managerial problem-solving method (MPSM)* describes seven steps in detail.

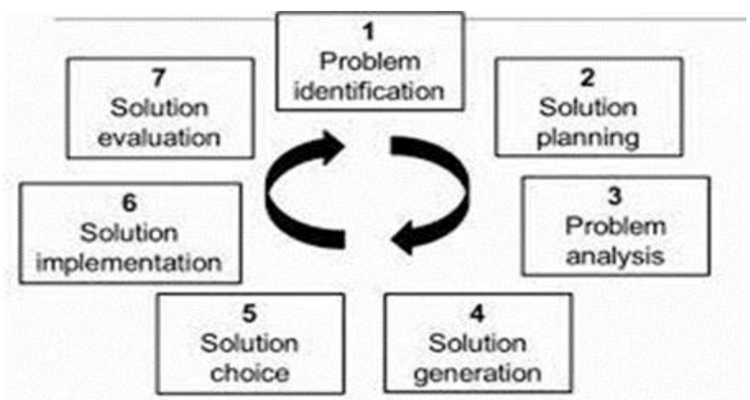

Figure 2. Managerial problem-solving method

There are seven steps in MPSM in total. First, I need to define the problem. In this phase, the current situation of the company is analyzed and the action problem is revealed. By implementing the problem cluster, I have the core problem and research questions can be generated. The approach formulating phase is now expressed in the use of the MPSM method. For the third step of analyzing problems, KPIs are selected and defined to help define variables and provide insights for measurement, the current performance within the return process is quantified to have a better visualization. The inspiration for new solutions during step four can be obtained through the literature review and brainstorming session, existing solutions are supported by literature whereas new solutions are generated through a brainstorming group. After generating solutions from different perspectives: operation process and resource management strategy, then implementation and evaluation will be fulfilled, and recommendations will be given to the company based on the outcome.

1.4 Scope and limitation

The time horizon of the research will last for ten weeks, and it specifically focuses on the Return department of the JD Logistics warehouse located in Venray, the Netherlands. The purpose of the research aims to help stimulate better resource management strategies as well as an optimized operation process so that a higher efficiency level can be reached. The cost-effectiveness and process productivity perspective will be discussed and illustrated to support decision-making. Some parameters are not covered in this session and details will be reflected in the research limitation.

As with the majority of studies, the design of the current study is subject to limitations. This research focuses on the return process whereas its connections with inbound and outbound are less considered. The operation process and resource management are regarded as the key aspects to improve, but resource management is more related to resource allocation and labor forecast. Therefore, the real management perspective is not covered. Furthermore, due to the time limit, only operation process related solutions will be implemented because this is the first priority aspect to investigate for the company. The resource management strategies hence will be based on historical Return department performance and get insights. The quality of data assessed for operator performance is not kept as highest. The primary data obtained is not up to date. During the ten weeks research period, I will not have access to the company system so that historical primary data be used. It is possible that some updates or solutions have occurred which make the situation and recommendation does not hold up any longer.

1.5 Research questions

Based on the problem definition and potential core problems, the main research question is defined: **How can operation process optimization and resource management strategy improve the return process efficiency?** To answer this main research question, several knowledge questions are needed to tackle parts of this main research question:

1. What does the current return process look like?

Sub questions: 1a. How is the physical and information flow of the current process structured?
1b. How is the current performance assessed?

In the first stage of the research, problem identification-related questions should be formulated. Based on this research question, descriptive research will be performed to gather information on the current situation. The information can be acquired from several perspectives including observation and standard operation process (SOP) reading. Observations will be the fundamental tool that is used for collecting quantitative data. In this method, I collect quantitative data through systematic observations by using techniques like counting the number of people present at the return process within a day and a particular working station or the duration of people attending the event in a particular working station.

The FOP and WMS system of the company also give insights into the current return process image and the database within the systems is visible for current performance analysis.

2. What theories can be applied to improve process efficiency?
Sub questions: 2a. What is the theoretical framework?
2b. How does it help efficiency improvement?

In the second stage, literature review related questions are raised. To answer the knowledge questions that appear, an explanatory study needs to be considered. A systematic literature review session is conducted here to answer the knowledge problem in terms of theories and one theoretical perspective is selected. Furthermore, the information provides insights for solution initiation.

3. What problems are now existing in the Return department?
Sub question: 3a. Who are the stakeholders for the core problem?

For the problem analysis, the questions are generated. An explanatory study is performed to analyze the current action problem and its core problem, their cause-effect relationships can be expressed in the problem cluster. The main data collection used here is observation and primary data exported from the WMS system of JD Logistics. By applying Excel functions such as pivot table and Vlookup, the problems are quantified and revealed solid. Operationalization is introduced with details in Chapter 3 under Section 3.4.

4. What are potential solutions to improve return efficiency?
Sub questions: 4a. What perspectives are to be considered while designing solutions?
4b. What methods can be helpful for solution generation?

As for solution generation and selection, the above questions are involved. Another explanatory study will be performed here. On the basis of literature review and brainstorming with the supervisor and employees at the company, solutions from both operation process and resource management strategy perspectives can be generated with the combination of business processes in practice. Each solution will be evaluated and analyzed with pros and cons. The solutions for the operation process will be chosen as it is the main concerning object of the company whereas the solutions for resource management will only provide insights for the company and not be chosen as an implementation plan.

5. How to implement and evaluate the chosen solution for the return process?
Sub questions: 5a. What are the outcomes?

The knowledge questions for the implementation and evaluation stages are listed. To fulfill the research, an explanatory approach is conducted. An implementation plan session with the supervisor at the company and shift leaders at the Return department will be conducted to further discuss the validity and feasibility of solutions in practice. In the implementation phase, JD Logistics will apply the solutions to the return process, and the productive plans for operators will be easily accessible under the supervision and guidance of JD Logistics. Evaluations based on solutions will include descriptive statistics that help to summarize sample data and make estimates. I can conclude operator performance-related information such as the numerical average of orders per operator can process per hour. Evaluations are based on a quantitative method which includes productivity and customer satisfaction perspective.

1.6 Deliverables

• Business process model (BPM) for the current return process
To reflect on the current operation mode, a business process model (BPM) for the return process is necessary for gaining an intuitive panorama. Business process modeling can help group similar processes together and anticipate how they should operate. The main purpose of business process modeling is to analyze the current situation and achieve better results through breakouts. With the help of the model, I can modularize operation processes and make adjustments under the premise of ensuring the control and consistency of the whole image.

• Operators’ performance statistics and analysis through pivot tables
A systematic analysis of operators' performance will be undertaken and therefore quantitative statistics are applied through pivot tables. Through the table, perception of resource management-related knowledge is obtained such as the mobility of operators, the number of operators on each type of job per day, and the productivity of operators on average. With solid data support, I can make recommendations on current resource allocation and managerial strategic planning.

• Return process efficiency and cost calculation
As the most significant component of the project, efficiency is the key for decision-making and strategy adjustments of the company. The efficiency generating formulas will be delivered and connections between each parameter will be interpreted to clarify the philosophy. The costs as a support tool will be useful for decision-making when making recommendations for the company in terms of operation process.

•Recommendations on both operator management strategy and process optimization
Recommendations are delivered at the end based on the evaluation outcome of the designed solutions. Insights and vision on both operation process optimization and resource management will be provided and elaborated. Research limitations and contributions are mentioned here in the meantime.

1.7 Assessment of validity and reliability

To assess the validity and reliability of the measurement of the research, their definition should be clarified first. Reliability refers to the consistency with which a method measures something. If the same result can be consistently achieved by using the same methods under the same circumstances, the measurement is considered reliable. Validity refers to how accurately a method measures what it is intended to measure. It encompasses the entire experimental concept and establishes whether the results obtained meet all of the requirements of the scientific research method (Mohajan, 2017).

During the reliability assessment, I use observation to obtain different perspectives on return process performance. If I repeat the measurement at a different time or different people conduct the same measurement, the results are most likely to remain unchanged or have small variations. My observation samples and populations are operators working on the return process, the outcome of the observation is also based on a duration of two weeks so that the average performance can be gained. Although there might be different operators selected from the human resource pool per day, all the return process operators are predicted to be involved within two weeks. The stability of the performance can be ensured when observing based on two weeks' time and leads to a slight negligible deviation and variation in outcomes. Therefore, the test-retest reliability and inter-rater reliability can be guaranteed even if the measurement is done at a different time or by different people.

To make sure of sufficient validity when conducting the research, the measurement should precisely and accurately measure what is required. Validity has two essential parts which are internal and external. Internal validity refers to the legitimation of the study of how the samples are selected, and how data are analyzed. External validity shows if the results are transferable to other groups of interest (Mohajan, 2017). To ensure internal validity, a literature review will be performed first to ensure the adherence of the measure to existing theory and knowledge of the concept being measured. Independent and dependent variables will be operationalized and defined to ensure consistent application of the methods. During the measurement phase, only primary data is used so that further deviations in collected data measurements are barely possible. There will be no prejudices while looking for solutions for the company. For external validity, the research has the characteristic of repeatability. The same result can be gained with different samples or settings with respect to the operator's performance. However, the transferability of the research to other fields of study can be possibly problematic due to the specificity. Therefore, additional considerations are necessary when testing the solutions in other research.

1.8 Reading guide

In the following chapters of this thesis, I will introduce content from different dimensions. Chapter 2. Literature review will introduce theories found helpful for efficiency improvements and the theoretical framework is defined. Chapter 3. Current situation analysis will include the warehouse payout, return process introduction and how the return process integrates with JD Logistics systems. The current performance will be measured with KPIs defined, variables in the main research question are operationalized. Chapter 4, Solution design will come up with solutions based on operation process and resource management strategies perspectives. The origin of solutions will also be discussed. Chapter 5. Solution test involves the implementation and evaluation of solutions. Only operation process related solutions are implemented and assessed based on KPIs. Chapter 6. Conclusions and recommendations answer the research questions as summaries, recommendations are given to JD Logistics based on the evaluation outcome from the operation process perspective and the historical performance of operators from the resource management strategy perspective.

2. Literature review

A systematic literature review will be performed to create an understanding of the research question:

“What theories can be applied to improve process efficiency?”

Section 2.1 describes three theories and chooses one theoretical perspective to focus on in this thesis. The relationship of how BPM impacts business efficiency is further investigated with empirical studies in Section 2.2. BPMN is introduced and selected as a technique and tool for BPM in Section 2.3. The concept matrix and chosen articles are listed in Appendix under *Appendix A. Systematic literature review*.

2.1 Theories and theoretical perspective

2.1.1 Lean Six Sigma methodology

Lean Six Sigma methodology is the combination of the Six Sigma methodology and Lean methodology in which they focus on different fields. Six Sigma focuses on quality rather than speed of the process, whereas Lean management is better for improvement in speed and process flow instead of improvement in quality (Atmaca & Girenes, 2011). Lean Six Sigma compensates shortage of each individual methodology and ensures a sustainable improvement of the operating result. A five-stage cycle is used to control the processing system called DMAIC, which represents define, measure, analyze, improve and control respectively (Pepper & Spedding, 2010).

Three strengths are revealed (Sixsigma, 2021): first, Lean Six Sigma lies a strong foundation for quality improvement. Second, the production lead time caused by defects and frustration is reduced, and time wasted on abnormal cases can be saved. Third, better operation results can be obtained. According to the principle, quality becomes the means to achieve the goal instead of the goal itself. It adds many values to customers and hence contributes to a better result.

2.1.2 Total Quality Management (TQM)

Total Quality Management is known as an approach to business that looks critically at the products and services a company provides in relation to the process operators to create them (Bonstingl, J. J., 1992). It is a customer-focused method that involves continuous improvement over time. The principles are based on several aspects (Chang, 2005):

1. Customer-focused: the final goal of TQM is to always benefit the end customer. Hence, customer satisfaction has a significant priority in the whole business.
2. Work processes focused: quality problems are mostly dependent on the work processes that are designed and manufactured the products and services. The focus on the work process can ensure the quality of products and therefore add value to customers.

3. Continuous improvement — quality improvement is endless to align with the goal of continually optimizing processes, employee learning is also a major part of carrying out quality improvements.
4. Data-driven management: systematic data collection, analysis and experimentation should be fundamentals for solution generation and adjustment. Inefficiencies can be identified by the use of solid data, and insights into where to focus improvement initiatives can be gained as well.

Companies that successfully implement TQM are able to reduce variability, providing the consistency that customers value. TQM also focuses on saving time and reducing waste with the help of high-quality information.

2.1.3 Business Process Management (BPM)

Business Process Management (BPM) is a discipline that uses various methods to discover, model, analyze, measure, improve and optimize business processes (Sarah Laoyan, 2021). It aims to eliminate complicated extra processes in the workflow so that contributes to better insight and efficiency of the collective workflows that make up a business process. The lifecycle of the Business Process Management can be explained in five main steps (Hammer, 2015):

1. Design: this very first step involves gaining an in-depth understanding of the current situation of the business. The organization profile is visualized through process mapping, and an analysis of potential process improvements can be performed.
2. Model: identification of primary, management as well as support processes are processed here. Considerations or models on how the business process runs in various circumstances are also discussed.
3. Implement: the model formulated is put to action and solutions are implemented for improvement. Standardization and process automation are both inclusive. Key success metrics should be set so researchers can gauge whether or not the changes made are successful.
4. Monitor: evaluation of the performance of the solutions. Improvements based on the key metrics are tracked and monitored to decide whether the project is successful or not.
5. Optimize: continuously improve the business process and strive to remove bottlenecks in this phase to make the process more efficient.

The BPM as a tool has the advantages of helping enhance organization performance, supporting corporate governance and having competitive advantages. Organizational process-based performance assessment methods can support the diffusion of BPM within organizations, by creating visible business processes by measuring intermediate and final results. As governance migrates initial BPM to integrated and systematic initiatives, it aligned with process management is regarded as an efficient implementation approach (Maciel et al., 2018).

Overall, BPM becomes the final theoretical perspective to focus on with respect to the situation of JD Logistics. The return process at JD Logistics is a flow process with successive operation steps, the customer service and product quality are important for its business development. However, for the internal Return department performance, the company emphasizes more on its own operation process in the current phase instead of the product quality. To achieve an overall high return efficiency, the process management has the most apparent advantage compared to the quality control. Customer satisfaction is not the leading primary task of the company under the circumstance of low efficiency, hence the TQM becomes less applicable. The Lean Six Sigma method as a combination of Lean method and Six Sigma, requires significant effort input when implementing top-down approach within the company. All layers of the company are involved and has a large impact on the company culture, worker motivation is essential to make the Lean Six Sigma effective throughout the company (Reijns, 2010). JD Logistics is now looking for a rapid transformation way without excessive actions, the Lean Six Sigma method needs the alignment from top to the bottom of the whole system which conflict with the company's goal and cannot fulfill the company's requirement. As a result, BPM becomes the most feasible theoretical perspective to solve the low return efficiency action problem. Through operation process optimization and strategy adjustment, BPM helps to expand the lifecycle of the business process and improve the performance, hence it becomes the first choice for JD Logistics.

2.2 BPM and efficiency

BPM was widely applied in the business industry to benefit the organizations and provide insights into strategy construction. It is shown that BPM strives for the improvement of how companies conduct cross-function work and ensures that company-wide capabilities are available that enable the business process life cycle (Haračić et al., 2018). The efficiency of the company is affected in a way that how business processes interact with each other. In order to improve these objectives, companies are expected to map their business process in alignment with business strategy and execute in accordance with the innovative plans. The most common motivations for improving BPM are twofold (Haračić et al., 2018): first, companies lack innovation and have outdated business processes. Second, companies want to improve the quality and consistency of their products or service. By identifying the current process performance, defining desired performance and coming up with realistic implementation plans, the organizations improve the BPM and remain efficient, effective and flexible in the processes in the fluctuating market (Bailey, 2017). In the research on the BPM industry, 94% of the companies have implemented or plan to implement BPM initiatives in the next 3 to 5 years (Thakral, 2011).

Several cases are selected and analyzed as an empirical study on how BPM can positively affect efficiency in an organization and contribute to the process mapping (Pritchard & Armistead, 1999). In the British Telecom case, a central Process Management Unit was used to guide process mapping. Processes were identified, defined and documented. An integrated Business Process Model of British Telecom emerged. Results are shared widely across the company and used to prioritize and target improvement activities. During the improvement phase, they empower operators at the end of the operation and remove rigidities from the process. Guided by problem-solving and process experts, they have successfully achieved a breakout that £1.3 billion worth of potential productivity improvements identified across the value chain.

Nortel as a communications solutions provider also consolidated its business status under the application of BPM in the late '90s (Pritchard & Armistead, 1999). A high leveled core process map is facilitated which concentrated on the core value chain and crucial steps from the customers' point of view. The mapping tool involved key aspects of value points that focused on outcome and decision points that helped manage boundaries within the organization. Corporate, regional and local business units are three process levels defined. During integration with business planning, Nortel aligned with a plan-do-check-act cycle to monitor and consistently improve the business process. With an appropriate BPM system, the Nortel successfully transformed from producing a complex one-off system and business service was developed.

In conclusion, a well-structured BPM follows the principle that organizations should first identify their current situation and processes, then process mapping is included as a holistic management tool. Objectives are set up in alignment with business strategy next and process improvements are based on this. Process implementation describes in a way how improved business processes integrate the practice. Evaluation of the outcome is obtained in the end and continuous improvements should be considered to contribute to more efficiency.

2.3 BPMN

Business process modeling and notation is a flow chart method that models the steps of a planned business process from end to end (Lucidchart, 2019). It visualizes the business activities and information flow within a certain process. As a key component and technique of Business Process Management, BPMN contributes to the revolutionary efficiency improvements and competitiveness change of business process.

A typical BPMN is usually composed of four elements: flow objects, connecting objects, swimlanes and artifacts. Three main flow objects are activities, events and gateways respectively shown in *Figure 3. BPMN flow objects below*.

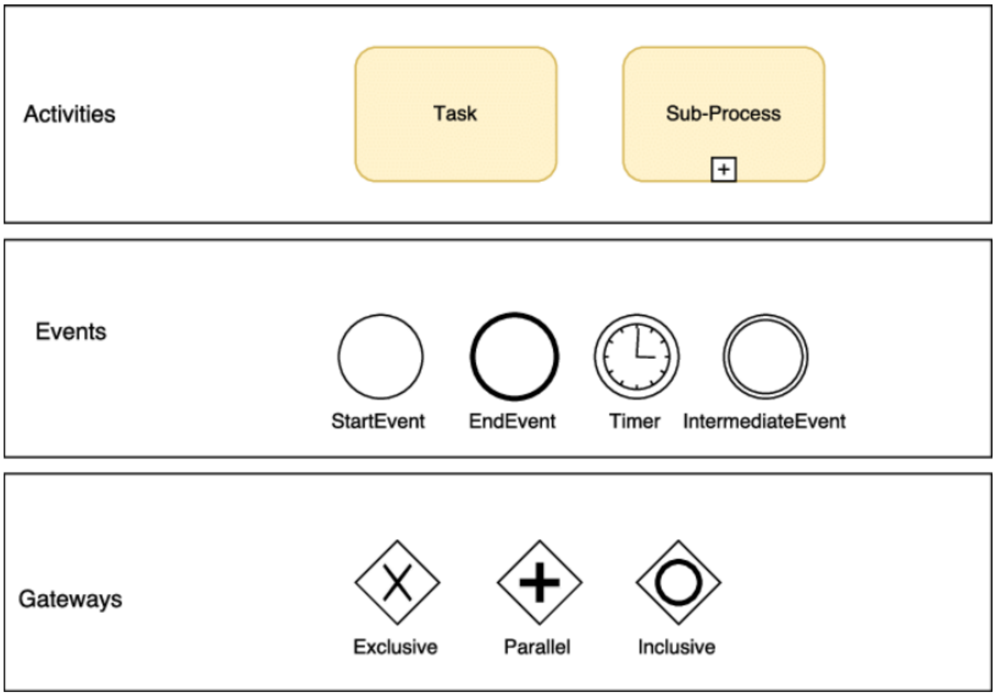

Figure 3. BPMN flow objects

Events are circular symbols that serve as a trigger that initiate, intermediate or end point of a particular process (Larissa Lewis, 2020). Popular event symbols include message, link, timer, error, escalation, etc. Events are all classified as catching or throwing dependent on their individual function.

Activities are illustrated in rounded rectangles that represent particular tasks and activities performed by a person or system. Common types of activities include task, sub-process, transaction and call.

Gateways are shaped in diamonds in BPMN. They are decision points that point out the direction a process shall turn next. Gateways can be exclusive or inclusive, parallel and event-based.

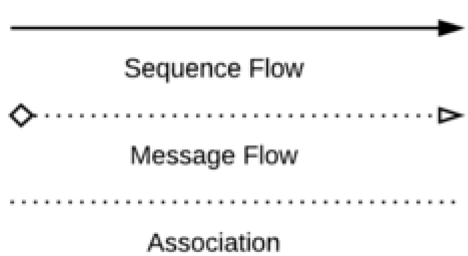

Figure 4. BPMN connecting objects

Connecting objects illustrate how different activities connect with one another. Sequence flow, message flow and association are three types of connecting objects that are widely used (see *Figure 4. BPMN connecting objects*). Sequence flow maps the activities sequentially to show their order and priority. It is shown as a straight line with arrow whereas message flow is shown as dashed line with arrow and circle at the start. Message flow indicates a message sent between participants. Association is expressed in a dotted line, it associates the relationship between different data and objects (Larissa Lewis, 2020).

Figure 5. BPMN swimlanes

The pool in the BPMN stands for the major participant like a department in the process. In contrast, a swimlane encompasses the activities and flow for a certain role. An example of pool and swimlane is shown above in *Figure 5. BPMN swimlane.*

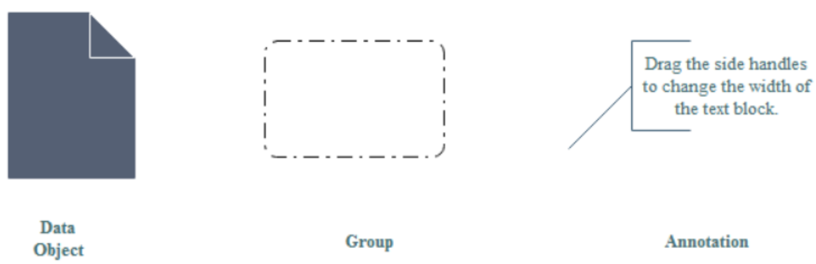

Figure 6. BPMN artifacts

Artifacts are the tools to add more information to BPMN (see *Figure 6. BPMN artifacts*). Data object as one artifact shows what data is required for an activity. A group shows a logical grouping of activities without changing the diagram's flow. An annotation provides further understandable impression to a part of the diagram (Allison Lynch, 2022).

2.4 Summary

In this chapter, a literature review is conducted to develop a theoretical framework for efficiency improvements in the return process. First, several theories on efficiency optimization are introduced with pros and cons. Then combined with the JD Logistics feature, the theoretical framework is chosen from the theories. Next, case studies are performed to investigate how the chosen theoretical framework improves efficiency in practice. Finally, one technique is selected and studied as the tool for the support of this research. the following research question and sub questions are answered in this chapter.

2. What theories can be applied to improve process efficiency?

There are three theories during the literature review that appears to be valuable for the research, they are Lean Six Sigma, Total Quality Management and Business Process Management respectively. Advantages and disadvantages of each of them towards business process are discussed in Section 2.1.

2a. What is the theoretical framework?

Based on the three theories, the Business Process Management becomes the ideal perspective for this research to use as the theoretical framework. BPM best fits the situation in JD Logistics with operation process oriented instead of focusing on product quality in TQM or triggering significant changes in the company's system in Lean Six Sigma. BPMN as one technique will be used as a tool under the theoretical framework to map the information and physical flow of the return process in JD Logistics (Section 2.3).

2b. How does it help efficiency improvement?

The cases of British Telecom and Nortel are analyzed as empirical studies on how BPM can positively affect efficiency in an organization and contribute to the process mapping (see Section 2.2). In conclusion, organizations first examine and evaluate the present processes through BPM. The processing mapping to visualize the current situation. Objectives are set up in alignment with business strategy next and improve processes. Implementation and evaluation need to be performed in practice with further continuous improvements. BPM ensures that processes are effective and cost-effective. It identifies and improves current processes so that companies become more efficient.

3. Current situation analysis

In this chapter, the current return process situation at JD Logistics is described with details. The following two research questions are answered in this chapter:

"What does the current return process look like?"

The first research question is answered from Section 3.1 to Section 3.4. In Section 3.1, the warehouse layout is introduced to provide an overview of the business. Section 3.2 discusses the relevant return processes to get a better understanding of activities within the warehouse. System analysis is conducted in Section 3.3 and interactions between operators and system are described. At last, Section 3.4 measures the current performance with KPIs.

"What problems are now existing in the Return department?"

Bottlenecks and stakeholders are further analyzed in the Section 3.5, in this case, the second research question above is answered.

3.1 Warehouse layout

To have a better overview of what the current layout in the warehouse looks like, a drift map is introduced in *Figure 7. Draft warehouse layout* is shown below. The areas with blue background represent what is relevant to the return process.

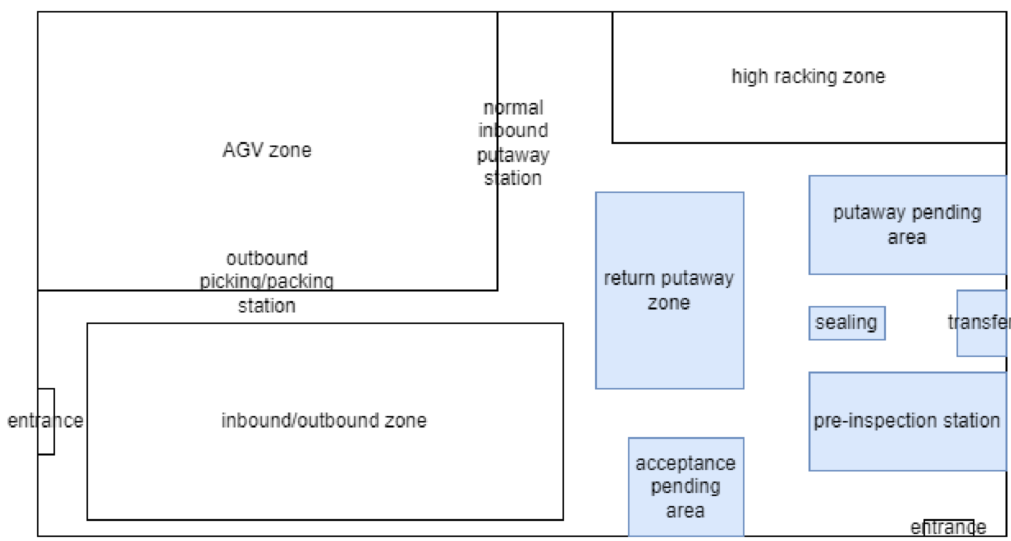

Figure 7. Draft warehouse layout

The AGV zone in the left-up corner is responsible for Hunkemöller inbound and outbound control. When inbound orders arrive at the warehouse, they will be first put in the inbound area and then directly put away in the AGV zone through the normal inbound station. Likewise, when the warehouse receives outbound orders, operators pick and pack articles from the AGV zone, completed orders are located in the outbound zone and wait for shipment. Therefore, the AGV zone is also said to be our inventory zone, through inbound putaway and outbound pickings, the inventory in the AGV zone varies constantly.

The high racking zone in the right-up corner is for our B2B cargoes. They mainly serve customers from Huami and Wowcher, and the high racking zone provides storage service for them. For these cargoes, we follow the pallet in and pallet out rule which indicates no further operating process is required. The forklift operator only needs to move the whole pallets on and off racking when inbound or outbound orders arrive.

The blue area shows the whole return process layout. The return parcels will be centralized at the acceptance pending area when they first arrive. The return team leader signs the proof of delivery (POD) document and arranges the pre-inspection tasks at the pre-inspection station. Transfer tasks will be done in the transfer station and the sealing machine will undertake the repack tasks of transferred articles, only articles with new sealed bags are qualified to be put away. Return orders will be moved to the putaway pending area when they finish the sealing, and finally be put away in the putaway zone by operators.

3.2 Process analysis

Within the return process, there are mainly four tasks involved: pre-inspection, transfer, sealing and putaway. In the pre-inspection stage, operators accept the return orders physically and informatically in the system. Through this way, we confirm that we receive the return orders from customers. Transfer tasks are needed when we transfer articles from the transfer container to the put-away container with different grades. Sealing must be done to make sure articles with brand new packages are qualified for outbound. Then putaway tasks are assigned automatically to make these transferred articles our inventory. Putaway means putting items on the shelf in our warehouse, these return items being put away have the same criterion as normal inbound products. In this case, we bind return and normal inbound together and constitute common inventory in stock. The return process is finished when the putaway task is done, a close-loop is generated and on-shelf return products can be outbound and shipped to customers again. A sustainable return process is cost-effective for both business partners and JD Logistics.

We classify return items into three grades: A, B and C. A grade means the returned products have good quality without damage or dirt, B grade means the products have slight wear and tear, but are still repairable and can be resold to Outlets. C grade basically refers to the products with missing labels and damaged, therefore these products cannot be processed and will be sent back directly to Hunkemöller to wait for Centralized destruction. Only A-grade items can be put away again on the shelf and become components of inventory. Then they can be located by outbound tasks, being picked and packed and finally delivered to the customers.

More details are shown in *Figure 8. BPMN of the current situation*. The tasks with orange filling mean they should be executed with RF scanners, in contrast, purple task modules represent tasks that need to be associated with PDA.

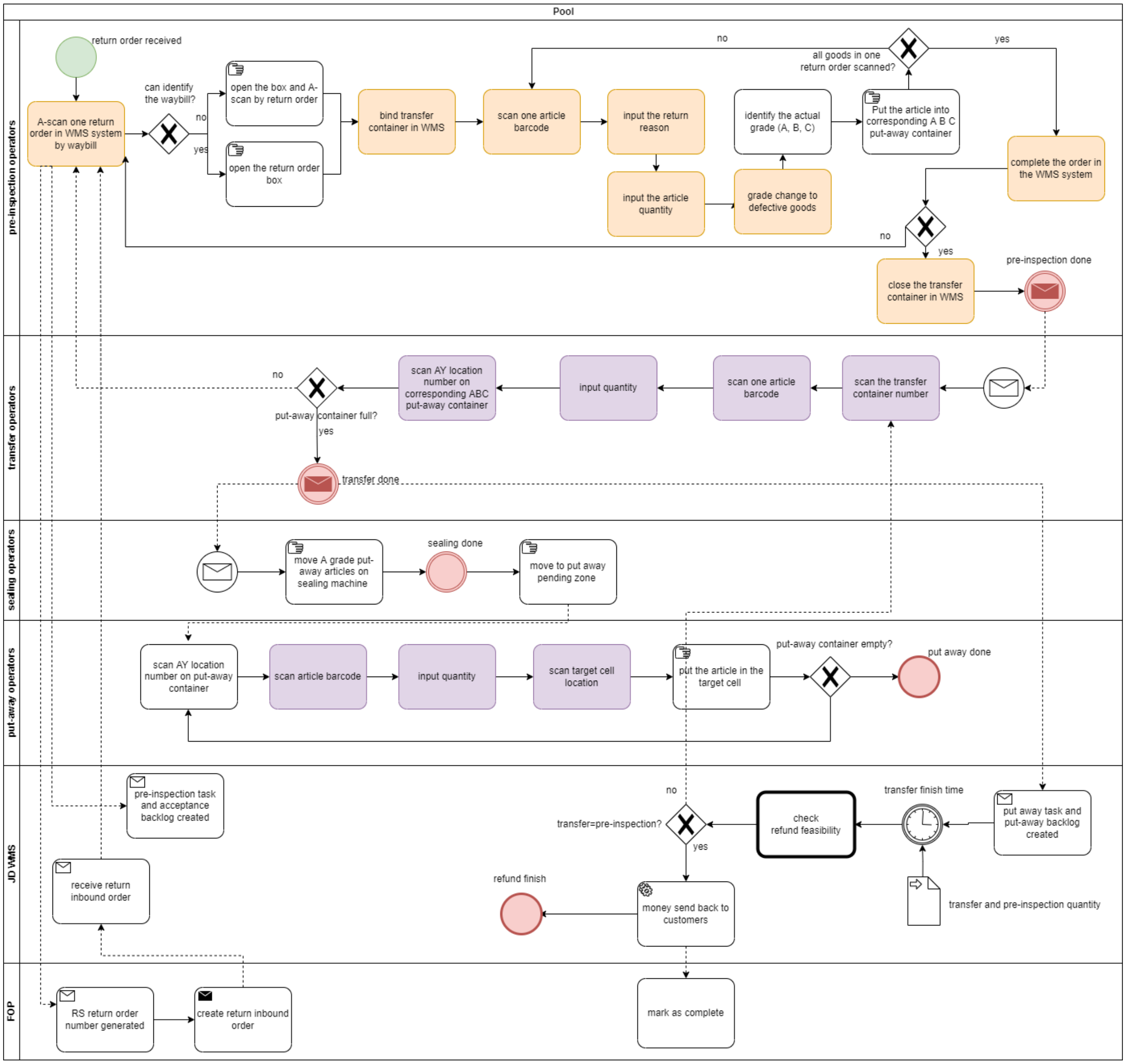

Figure 8. BPMN of the current situation

3.2.1 Pre-inspection

The pre-inspection refers to the process to accept return e-commerce orders to our warehouse and it uses an RF scanner as well as a WMS system to accomplish tasks. RMA inspector first does A-scan which means scanning the waybill on one return package to create a return order task, then binding the order to a transfer container by scanning the container number. If the waybill outside the parcel cannot be recognized by the system, then the RMA inspector should open the box and scan the return order number on the return sheet inside the return parcel. The product information interface is shown on the PC after binding with the transfer container, the inspector checks the quantity and identifies the quality of articles returned. The grade of each item should be evaluated and recognized on A, B, and C levels. Afterward, the inspector scans the barcode of each article and input quantity. In case some articles do not belong to this return order and hence cannot be recognized by the WMS, the RMA inspector should report the issue to the return team leader and register it in the shared documents. Therefore, everyone in the office is aware and has access to the issue history. The return reason indicated on the return sheet of the customers should be recorded and selected in the WMS as well. We regard all returned products as defective in the system and scan items one by one till all articles in the order are scanned. The pre-inspection is said to be completed when inspectors finish the order complete and close the transfer container in the WMS system. The transfer task can and only can be generated and implemented when these two steps are done.

3.2.2 Transfer

All items in one return order are located in the transfer container scanned in the first place in the system, transfer needs to be done to further differentiate their grades. Transfer means transferring items from the transfer container into three put-away containers with A, B, and C grades, in this case, items in one return order are classified into three grades. Therefore, the transfer task is binding with the grade identification function. Each put-away container with grade is labeled with an AY location number in which AY stands for defective goods locations in the WMS system. We have defined all return products as defective during pre-inspection and that's why we put them into AY defective locations. Transfer operators need PDA to do transfer and they scan the container number of the transfer container as origin, then they scan the barcode of the article and input quantity. The AY location number on the put-away container should be scanned at last in accordance with the article grade.

The operator transfers all articles in the transfer container till it is empty. When the put-away container is not full, the inspector picks the next return parcel and repeats pre-inspection and transfer operator transfers till the A grade put-away container is fully loaded. Only A-grade products can be put away as introduced, and A-grade put-away containers are assigned by the sealing operator to the sealing machine to be sealed and then to the pending area waiting for the putaway. Putaway tasks are automatically created and become putaway backlogs as long as the transfer comes to an end.

3.2.3 Putaway

Putaway means processing return orders from the pending area and making them on the shelf so that they become part of warehouse inventory. These inventories will be picked and packed during outbound processes when customers push orders. Putaway operators first pick one put-away container that contains pre-inspected return articles. With the PDA putaway function, they scan the AY location number stick outside the put-away container and pick one item out. Then the barcode of the item should be scanned with quantity input, then select grade as non-defective on PDA since these are actual A grade items. The Putaway operator chooses one free cell location in the putaway zone and scans the cell code. After pressing the confirm button, the putaway task is completed informatically in the WMS system. When the operator puts the article into the cell location, the putaway task is completed physically. *Table 1. Process summary* below summarizes the steps that need to be done on different devices for different tasks.

Pre-inspection (RF scanner)	Transfer (PDA)	Putaway (PDA)
A-scan	Scan transfer container number	Scan put-away container's AY location number
Scan transfer container number	Scan article barcode	Scan article barcode
Scan article barcode	Input quantity	Input quantity
Input quantity	Scan put-away container's AY location number	Select grade as non-defective
Select return reason		Scan destination cell number
Select grade as 'defective good'		

Table 1. Process summary

3.3 System analysis

3.3.1 WMS system

WMS system serves internally for the warehouse to assist inbound, inventory and outbound. It monitors the overall performance of the warehouse and information is recorded within. While doing pre-inspection, the acceptance backlog which refers to orders waiting to finish pre-inspection is automatically created and added to the WMS system under the backlog function after A-scan. As long as the A-scan of the return order is done, the acceptance backlog appears and will last till the pre-inspection is finished. Then putaway backlog plays a role, it is generated when the transfer is done and articles are allocated in the put-away containers with the AY location number. To enable the putaway tasks, order complete and close transfer container in WMS are two crucial steps at the end of pre-inspection. The articles will either fail to put away or the putaway task cannot be found on PDA if one of the two steps fails to execute.

The customers will get their refund when the acceptance quantity equals the transfer quantity of the return order. When all articles of one return order scanned in pre-inspections are transferred, this is the time we call refund point and WMS will authenticate and push through the refund process. In this way, customers receive their money and we ensure we have received all return items in stock.

3.3.2 FOP system

FOP system undertakes the responsibility to connect WMS and Hunkemöller. It helps to communicate and send information to Hunkemöller about the status so that transparency of the business can be guaranteed. Business partners can also use it to track and trace orders to monitor overall operational performance. When customers order articles online, Hunkemöller collects the order information and sends it to the FOP system. In regards to the return order, the return serial RS number is immediately transferred and recorded in FOP when A-scan is executed by the inspector. Then it conveys the message that the return order is received to WMS so that further pre-inspection steps can be processed. The status shows released to warehouse and it means this return order has been A-scanned and in progress. The status turns to complete at the time when the transfer of the return order is done and WMS agrees on the refund point. Hunkemöller then realizes this return order is completed with the refund.

In conclusion, WMS and FOP are two platforms widely used for assisting the management as well as the monitoring of the warehouse and operation process. WMS tends to internal warehouse management, it combines performance review and operation functions together as an integrated system. Both office workers and RMA operators can log in and take advantage of WMS to finish their tasks. In contrast, FOP serves mainly business partners and it is a bridge that connects the warehouse with the partner. Through FOP, the status of orders can be obtained and updated to both WMS and Hunkemöller, relationships among platforms and stakeholders based on it are maintained at a level with practical effectiveness.

3.4 Measurement of performance

3.4.1 Operationalization

According to my research question, three concepts are defined that are: operation process, resource management and return process efficiency respectively. The KPIs are listed in Table 2. KPIs and measurements. For the operation process, its variable is the productivity of the operation process that can be operationalized by productivity at each task. Another indicator for the operation process is defined as customer satisfaction which is related to all return processes and is crucial for JD Logistics to solve and optimize. It is measured in terms of the number of orders refunded to customers per hour by one operator.

KPIs	Measurements
1. Productivity at each task	The number of orders one operator can process per hour at each task
2. Overall return process productivity	The number of orders one operator can process as a whole return process
3. Customer satisfaction	The number of refunds can be processed by one operator per hour
4. Mobility of operators	Types of jobs done by one operator per day
5. Effective working hours	Translated total productive working hours per operator

Table 2. KPIs and measurements

For resource management, I choose operator performance as the variable. This variable can be expressed in terms of mobility and effective working hours. Mobility means the types of jobs done by one operator per day, and it is measured by a quantitative method similar to productivity, the measurement of productivity will be the same as what is introduced in the next paragraph in the return efficiency. The effective working hours represent the average operators’ contribution hours to work per day, it not only helps to monitor the whole return process but also provides insights for future resource allocation.

The overall productivity becomes the variable for return process efficiency. Common measurements of employee productivity are the quantitative method, task tracking, objectives method and profit measures (Mia Naumoska, 2021). The productivity here refers to the number of orders per operator can process per hour within the whole return process. Therefore, the quantitative method based on measuring productivity by the number of products an employee makes during a particular period of time and the objective method based on how well employees are able to meet their objectives can be applied. In this case, clear and individual goals are set as a baseline to measure productivity.

3.4.2 UPT of return orders

Units per transaction (UPT) stands for how many items customers add to their shopping cart per transaction. It is used to be an important KPI in the retail sales field to measure how customers behave and purchase during each visit. For our return process, we define UPT as the number of articles returned in each return order. We assess the unite UPT by dividing the number of items returned by the number of transactions for the period. With the help of return UPT, the connections between return orders and return items can be built with quantitative measurement and will be beneficial for further performance evaluation. The following UPTs are calculated on the monthly basis from WMS and insights can be gained.

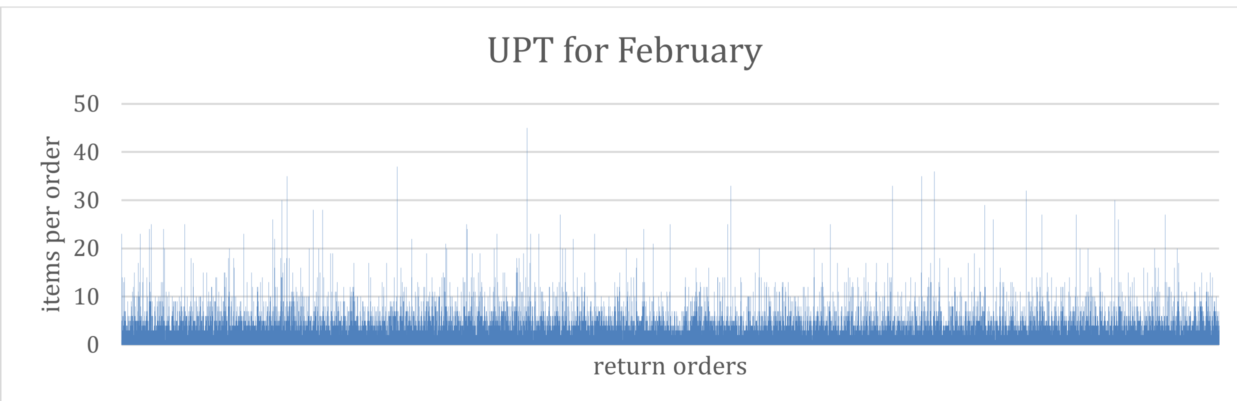

Figure 9. February return UPT

Figure 9. February return UPT above shows an overview of return order performance in February. There were 52781 return orders with 16965 articles in total. The UPT equals to 3.11 by using formula:

Return UPT = number of items in total/number of orders in total = 16965/52781 = 3.11

Therefore, there were on average 3.11 items in one return order in February.

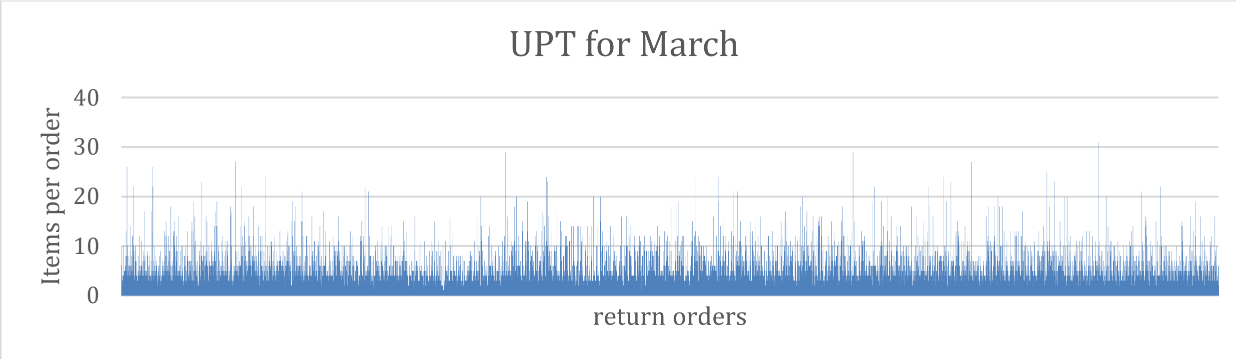

Figure 10. March return UPT

Through observation in March, there were overall 54524 return orders with 17248 articles. *Figure 10. March return UPT* shows the UPT equals 3.16 according to calculation. In conclusion, the general return UPT is approximate 3 which is considered the index used for the whole performance review and assessment. While productivity is expressed in terms of orders, we get insights into productivity in terms of pieces with the return UPT of 3. If an operator processes one return order, it is equivalent to that he processes three pieces of returned articles. This will be used as a reference and instruction in the overall performance as well as productivity production in my research.

3.4.3 Current performance

To have an overview of the current return process efficiency, JD Logistics carries out measurements on a weekly basis. The *Table 3. Measurement of performance* below shows measurements of reality that the company is facing from diversified perspectives.

Role	Productivity/orders/h	Productivity/pcs/h	Working hour	People	Target
Inspection	11	33	90.91	11.36	1000
Transfer	40	120	25.00	3.13	
Put away	19.33333333	58	51.72	6.47	
Sealing	93.75	281.25	10.67	1.33	

Table 3. Measurement of performance

According to the measurements, there are four types of tasks that can be operationalized in the return process in total. They are inspection, transfer, putaway and sealing respectively. The inspection here refers to pre-inspection before the transfer task. The productivity of each task refers to the number of orders or pieces of articles per hour per operator can process. The target order number to be processed is 1000 and working hours are based on this cardinality. 8 hours of working time per operator per day are recognized and agreed upon. Look at the inspection phase as an example, one inspector can process 11 orders per hour and that means 33 pieces of articles based on the return UPT of 3. If the inspection station aims to finish 1000 orders then it will spend 90.91 hours for one single inspector, or 11.36 inspectors to work simultaneously together within one hour. Other rows of tasks follow the same principle. For the transfer task, one inspector can finish 40 return orders in an hour whereas one put away operator can only put away around 19 orders in the same amount of time. The sealing task has the most efficient productivity of processing 93.75 return orders per hour. We can observe that the inspection stage needs the most working hours and hence has the most improvement potential. The total number of operators needed is almost 20 when the return process is loading with a full capacity which brings considerable costs for the company due to the low profitable characteristics of the return process. The putaway operator's productivity is around twice the inspector's productivity which leaves inspection high pressure as well as a huge buffer for putaway. All these arguments compose the reality of the return process.

target orders	1000	
working hour per people	8	
	productivity(orders/h/ppl)	working hours
inspection	11	90.90909091
transfer	40	25
put away	19.333333	51.72413882
sealing	93.75	10.66666667
total working hours(h)	178.2998964	
total people(ppl)	22.28748705	
total productivity(orders/ppl/day)	44.86822573	

Table 4. Return productivity

Table 4. Return productivity shows the calculation phases for overall return productivity. The overall return productivity also follows the same target of 1000 orders and 8 hours working hours per operator. Working hour per operator equals to target order number divided by productivity (orders/h) per operator. The total working hours can be calculated by summation of the working hours per operator. By dividing 178.29 total working hours by 8 hours per person, the total number of people needed under 1000 return orders is 22.28. Eventually, the overall productivity for the return process is 44.87 orders per person when applying the target 1000 orders over 22.28 total people needed. It means in terms of eight working hours per day, one operator is capable to finish 44.87 return orders from pre-inspection to putaway.

target orders	1000	
working hour per people	8	
	productivity(orders/h/ppl)	working hours
inspection	11	90.90909091
transfer	40	25
put away	19.333333	0
sealing	93.75	0
total working hours(h)	115.9090909	
total people(ppl)	14.48863636	
total productivity(orders/ppl/day)	69.01960784	

Table 5. Refund point productivity

The refund point productivity has a computation model very much identical to the return productivity except for putaway and sealing, see *Table 5. Refund point productivity*. Since the refund point is defined when pre-inspected products in a return order are all transferred, no sealing or putaway action is required. Therefore, I only take into consideration of inspection and transfer phases during calculation. The result indicates that one return operator can process on average 69 return orders with valid refunds in eight hours of working time per day.

3.5 Overview of problems

In this thesis, we focus on the most important problems that JD Logistics is now having and solve them. JD Logistics regards all potential problems as valuable and wants to better control them to tackle the low-efficiency action problem in the Return department. The operation process comes along with complexity and unintelligence. For a single task, operators have to open different pages in the WMS system to operate and process return orders. The information input method of the current return process also needs operators to switch between the keyboard, mouse and the scanner. These complicated steps significantly waste operators' time, especially under the circumstance of high repetitive operation processes like the return process. There are four different tasks in the Return department including pre-inspection, transfer, sealing and putaway. However, the Return department has the lowest priority but the most profit margin compared to the Inbound and Outbound departments. It indicates that the overall task types should be reduced so that on the one hand residual productivity can be assigned to other departments with high priority, on the other hand, more costs can be saved with fewer operators involved in the return process, hence the return process becomes cost-effective and adds more value to the company.

The resource management strategies are not intelligent enough. First, the current return process has around 20 percent of operators who have high mobility among tasks which means they get in touch with three or more types of tasks per day. This will lead to time waste during job handover and is considered an efficiency loss. Operators are highly likely to leave tasks unfinished for the next shift which brings confusion. The new operator may leave the unfinished task aside and make new pre-inspections or putaway, more abnormal cases are revealed in this case. Second, the order forecast is not precise enough for the company to operate on a daily basis, JD Logistics makes statistics based on historical data of five months and gets a conclusion of around 400 return orders are received daily. And this is the return order forecast quantity to be used in the later phase for everyday labor arrangements. It is apparent that the return order quantity varies from day to day and this estimation method is no more accurate for the company. Overstaffing or understaffing always happens which leads to profit loss or productivity loss. Unstable and irregular return orders need more scientific methods to forecast so that we can have more cost-effective arrangements for labor. Third, the resource allocation method within the company is unstructured and remains undefined. The team leaders usually randomly assign people to task stations according to their experience whereas the judgment and decision can be erroneous. Backlogs among tasks are retained at a high level which means many return orders cannot be finished within 24 hours. The Return department then miss performance indicator and lose profits.

Due to the principle of the refund point, it is not an efficient method with good customer satisfaction. In the current circumstance, the refund can be triggered only if the transfer quantity matches the acceptance quantity. But it happens when articles are dropped or misplaced in other containers by the operator, the transfer quantity will be less than the pre-inspection quantity in one return order and hence refund process is blocked. The return team leader collects all these abnormal cases and performs centralized processing to ensure a successful refund. Furthermore, operators always remember to close the transfer container to process transfer whereas order complete task is regularly forgotten behind. These return orders cannot be put away without the order complete and hence have to wait for the automatic order complete function. This function recognizes return orders in the acceptance backlog which stay over 24 hours and triggers the order complete task, the putaway task can process as normal. Although with the help of automatic order complete, the refund point is postponed due to the 24 hours time gap. The long waiting time for refund increases the complaints from customers and contributes to lower customer satisfaction.

3.6 Summary

This chapter describes the current situation of JD Logistics and the return process. First, the warehouse layout is introduced with diversified functional zones. The return process related area is also shown in Section 3.1 to have an overview. Next, the current return process is interpreted with a BPMN flow. Tasks including pre-inspection, transfer and putaway are illustrated in detail with their interrelations. Then system analysis is conducted to integrate the return process with the WMS as well as the FOP systems of JD Logistics. Finally, KPIs are defined and the current performance is assessed with refund point productivity and overall return process productivity. The following research questions and sub questions are answered.

1. What does the current return process look like?

The overall layout of the current return process is introduced under Section 3.1. Several working stations are revealed including pre-inspection, transfer, sealing and putaway. Acceptance and putaway pending areas are also mapped. The return process follows the sequence starts with pre-inspection, then return orders are sent to the transfer station. A-grade products will be sent to the sealing machine from the transfer station, final putaway will be processed at the return putaway zone.

1a. How is the physical and information flow of the current process structured?

The information and physical flow of the return process are mapped in BPMN under Section 3.2. As a tool for visualizing the process flow, it draws how return orders and products are received and processed in the warehouse. The return orders start with the pre-inspection task to be first accepted, then return products are sent to the transfer station to have further grade identification. All return products are classified into three grades: A, B and C. Only products with A grades can be put away and become inventories in the warehouse. These identified A-grade products will be repacked at the sealing station after transfer. Then final putaway will be conducted at the return putaway zone. The interactions of the return orders with the WMS and FOP system are also shown. The refund point is recognized in the WMS system when the transfer product quantity within one return order equals the pre-inspection quantity, then money can be sent back to customers.

1b. How is the current performance assessed?

To assess the performance and operationalize the variables in the research question, KPIs have to be formulated. Then the current performance is analyzed based on the KPI 1: productivity at each task; KPI 2: overall return process productivity; KPI 3: customer satisfaction. Measurements of KPIs are listed under Section 3.4.1. Through the observation data collection method, we get information on KPI 1. Based on a return order target of 1000 and 8 hours of working time per operator, we calculate the estimated working hours per task. Total working hours and total operators needed can be obtained by summing the working hours up at each task and dividing by 8 hours per operator. Final overall productivity is generated by using 1000 target return orders by total operators needed, then we have the number 44.87 which means one operator can process around 45 return orders from pre-inspection to final putaway per day. The refund point productivity follows a similar principle, however, the current refund point only involves the pre-inspection and transfer. Hence, the productivities of other tasks are not considered. As a result, one operator can process 69 orders refunds per day.

3. What problems are now existing in the Return department?

JD Logistics is now facing a problem of low efficiency of the return process in the warehouse. This action problem on the one hand negatively affects customer satisfaction when customers cannot receive their refund in a short valid time, on the other hand, considerable working hours need to be paid to laborers which bring the company a low margin. As a coherent logistics system, the outcome of the return process also connects to the performance of other departments such as inventory and outbound. Therefore, solving the low efficiency in the return process is prioritized and urgent.

3a. Who are the stakeholders for the core problem?

Two potential core problems are recognized. First, the Return department has poor resource management strategies which lead to both inaccurate return order forecasts and inappropriate labor arrangements. The operators in the warehouse are the direct stakeholders because any changes and modifications in resource management strategy can affect their performance and attendance. Second, the operation process within the return system is complicated. Numerous user-unfriendly steps waste operators' time and hence lead to low return efficiency. The company itself becomes the greatest stakeholder in this problem, it is related to the operation structure of JD Logistics. The company is motivated to optimize the operation process so that the framework can be developed with a long lifecycle, the efficiency can be improved as well which leaves the company more profitable.

4. Solution design

In this chapter, problem-oriented solutions are designed and the research question is answered:

"What are potential solutions to improve return efficiency?"

Section 4.1 designs the solutions from the operation process perspective and Section 4.2 proposes solutions in terms of resource management strategies. Both sections compose available solutions for the Return department which are applied in the later implementation phase. Section 4.3 introduces the origins of solutions including the requirement and how solutions are generated in practice.

4.1 Operation process

4.1.1 Cancel put-away containers

In the current system, articles of a return order are first pre-inspected into a transfer container and then assigned into put-away containers with grade differentiation, the final putaway task of the article is conducted from put-away containers to the shelf in the putaway zone. In this working function, two types of containers are involved in the transition from pre-inspection to putaway task. In *Figure 11. the old steps,* and detailed procedures before putaway tasks are listed and shown. The green tasks represent the tasks done by the inspector whereas red tasks mean tasks done by the transfer operator.

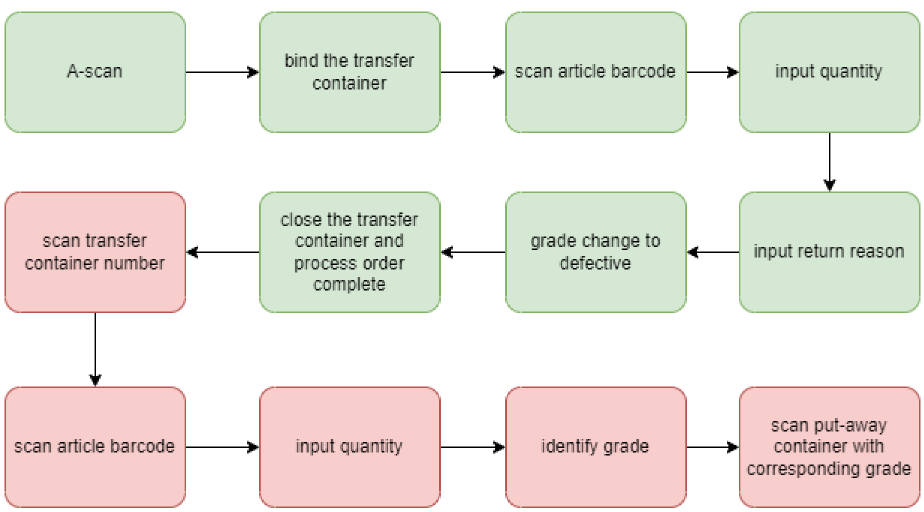

Figure 11. The old steps

However, if we bind the transfer container with the grades identification function, can put-away containers be canceled so that the process is simplified? In this initiation, inspectors check the quality of articles and bind them with corresponding transfer containers with grade identification. If the next article does not belong to the same category as the previous scanned article, operators can change the containers to locate it in a different transfer container with the correct grade. Then transfer containers with an A grade can be put away by operators.

We classify return items into three grades: A, B and C. A grade means the returned products have good quality without damage or dirt, B grade means the products have slight wear and tear, but are still repairable and can be resold to Outlets. C grade basically refers to the products with missing labels and damaged, therefore these products cannot be processed and will be sent back directly to Hunkemöller to wait for Centralized destruction. Only A-grade items can be put away again on the shelf and become components of inventory. Then they can be located by outbound tasks, being picked and packed and finally delivered to the customers.

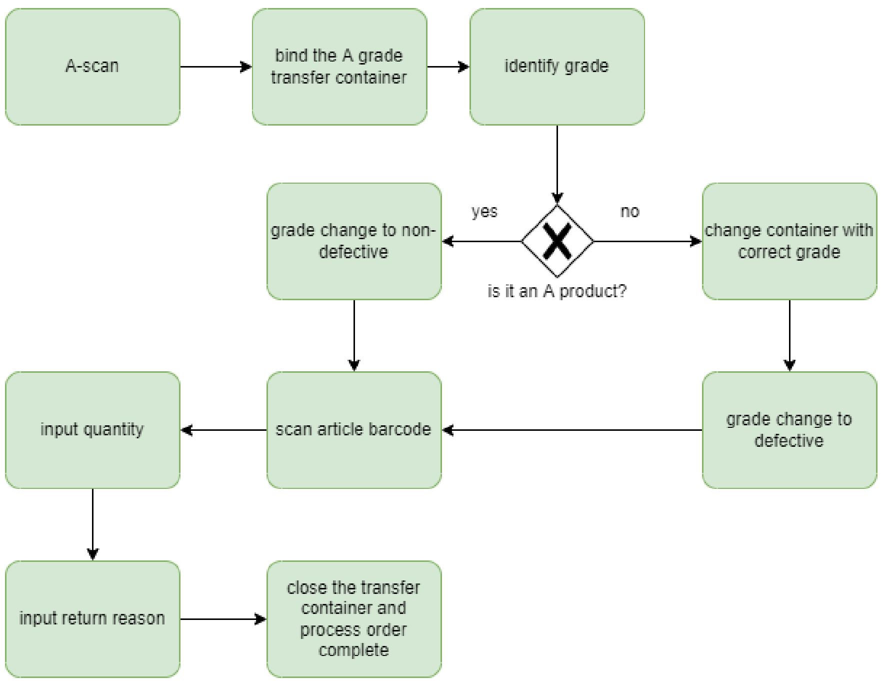

Figure 12. The new steps

During this new function, we eliminate the transfer process which refers to the procedure of transferring from the transfer container to the put-away container with grade. Now the transfer container and put-away container are combined into one container but preserve the characteristics of both previous functions. In this case, transfer operators are not needed anymore which saves a lot of labor resources and working time for the company. *Figure 12. The new steps* show the way of working before the putaway if the proposed solution is implemented into practice. As observed, transfer operators will not be a part of the pre-inspection and the total steps that need to be done before the putaway are significantly decreased compared to the old steps.

4.1.2 Pre-inspection information input

During pre-inspection, there are considerable operation steps that need to be done by scan or manual input. Manual input on PC not only costs efforts for RMA inspectors but also the transition time while switching between scanning and manual input is time-consuming. while brainstorming the pre-inspection efficiency optimization solutions, we should take the information input function into account so that pre-inspection can be a both user-friendly process for operators and an efficient process for the company. Therefore, a win-win situation can be realized.

Two alternatives for optimizing the current pre-inspection function are identified as partial scan and full scan. The full scan replaces all manually input steps in pre-inspection into scanning. In contrast, the partial scan still leaves grade selection (defective or non-defective) as manual input whereas other else steps are replaced with scanning. Further decisions on which method to use still need implementation and evaluation phase to test. The consideration of these two differences is because of the new process proposed. As agreed with Hunkemöller, the proportion of A-grade articles in stock should be 90%, B-grade articles 7% and C-grade articles 3% respectively. We are responsible to pay attention to any actions that may break this balance. If A grade inventory proportion increases, Hunkemöller takes serious consideration that our pre-inspection is not rigorous enough so that a certain amount of defective goods are marked as qualified and will be sold to customers again from our warehouse. Complaints from consumers will raise and damage the Hunkemöller's image and eventually lead to a low market share. On the other hand, when B and C grade articles in stock have more than a 10% scale, it means excessive defective goods will be sent to Outlets or destroyed. This causes a profit loss for Hunkemöller and negatively affects the partner relationship to be maintained. As a consequence, quality control during the pre-inspection is crucial and necessary.

In the partial scan, the WMS system on PC will regard the non-defective grade as the default setting due to the fact that most return articles are pre-inspected as A grades which indicate non-defective. This default setting will help speed up the pre-inspection process whereas the quality control can potentially become a hidden problem. Cognitive inertia describes RMA inspectors having the tendency to maintain the status quo which is the non-defective grade when unqualified products arrive. The reluctance of changing grade options by operators can significantly impact the A grade proportion to above 90% agreed upon. Quality control may fail to act in accordance with the routine, in this case, the full scan that proactively selects the product grade comes up as a controlled trial to verify the feasibility of both methods.

4.1.3 Advance the refund point

The current refund point is recognized when the number of transferred articles is equal to the number of pre-inspected articles within one return order. This way we ensure all products within one return order are received. But what if we advance the refund point to pre-inspection? It means at the end of the pre-inspection, the refund can be triggered when the order complete task of the return order is confirmed at the new refund point concept. We not only make sure that all return articles in the return order are received but also the customers can receive their refund in no time with fewer abnormal cases. In the old function, there are exceptions happening during transfer so that the criteria for the number of transferred articles is equal to the number of pre-inspected articles fails to be fulfilled. The refund time seems endless for customers in this case when these exceptions are centralized and wait for handling. However, the new function on the one hand advances the refund time of customers when pre-inspection is finished. On the other hand, it avoids abnormal cases during the transfer process because the transfer will not be involved in the new refund point so that customers receive their money faster. Customer satisfaction due to the quick refund can be raised and helps to consolidate a better connection with Hunkemöller. A visualized comparison between the old refund point and the new refund point is shown below in *Figure 13. Old and new refund point.*

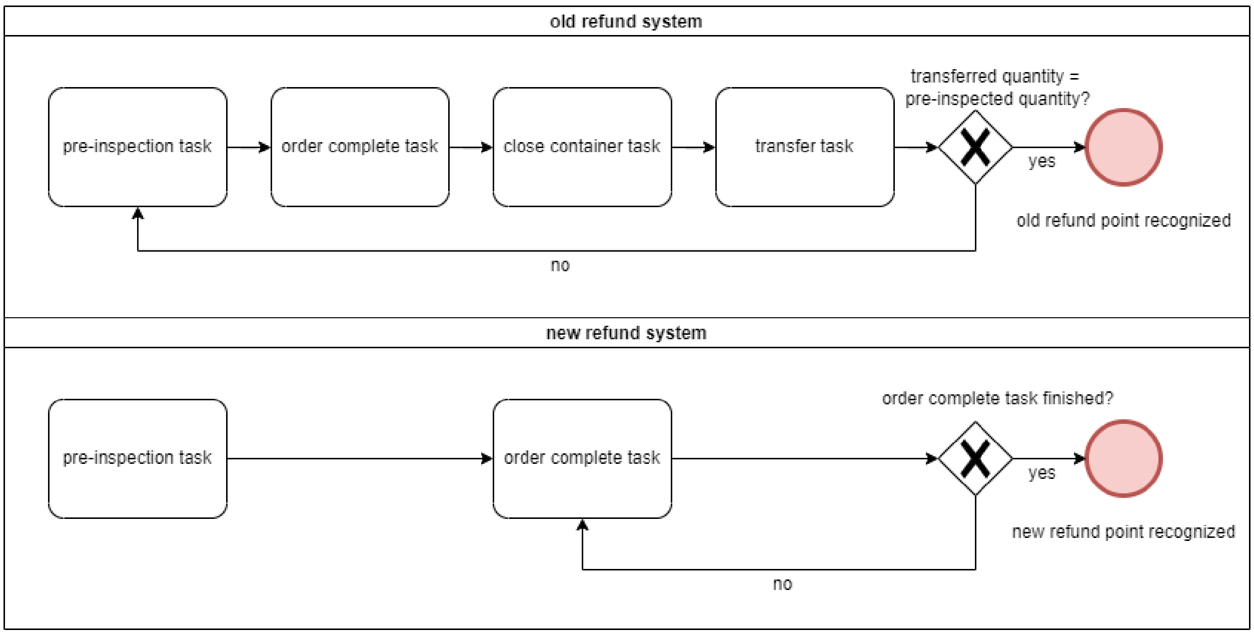

Figure 13. Old and new refund point

4.1.4 Putaway to AGV zone

In this initiation, the putaway zone is transferred from the current area to the AGV area. According to one of the requirements of the return process, the putaway of articles should be done within 24 hours after pre-inspection. However, due to the inventory capacity constraint of the putaway zone, some articles cannot be put away when there are no destination cells available. The return team leader either adjusts the picking process speed at the putaway zone to spare more spaces for the putaway, or the articles wait till automatic picking of the normal process and are put away when there are empty cells. This long putaway waiting time leads to KPI loss and articles cannot be put away in time. One potential solution is switching from the current putaway zone to the AGV zone to putaway. On the one hand, the AGV zone inventory capacity is around 50 times larger than the current putaway zone, hence there will be rare situations where putaway backlogs are waiting because of the full loaded capacity of the putaway zone. On the other hand, since processes at the AGV zone are conducted by PCs instead of PDA scanners of the current putaway zone, putaway operators can easily access the WMS system on PCs to figure out and fix abnormal cases. It is also a time-saving procedure when the return team leader does not have to collect all abnormal cases and the putaway can only be continued after the trouble shootings, individual operators can find out the problems and finish the putaway without waiting. With the new putaway function, we integrate the normal inbound with the return inbound at the inbound workstations and hopefully contribute to a more efficient return process.

4.2 Resource management strategy

4.2.1 Mobility

To investigate the correlation between operator performance and mobility, quantitative data analysis needs to be done through Excel functions including pivot table and VLOOKUP. I acquire and observe historical data from the WMS system and select February 23, 2022 to February 28, 2022 as sample date intervals for performance analysis. In the *Appendix B. Table 23. Overall pivot table* shows the statistical result obtained from the original database, I summarize all task types within the warehouse to start with a broad view of the regular pattern and then dive deeper into the Return department to verify if the same principle applies. The table shows the types of tasks per operator deals respectively with the productivity of each type of task, the productivity here is meant by the quantity of pieces of products done per hour. Under the column "name", different accounts are listed and each account represents one individual operator in accordance with the one operator one account regulation of JD Logistics.

	type of task	normal pre-inspection	normal put away	picking	binning	packing	return pre-inspection	return transfer	return put away		
	productivity(pieces per hour)	1050	500	1400	900	500	33	120	58		
time	name	normal pre-inspection	normal put away	picking	binning	packing	return pre-inspection	return transfer	return put away	mobility	working hours
2022-02-23											
2022-02-23	Venpk1@jd.com		384			150				2	1.068
2022-02-23	Venpk100@jd.com			3				2		2	0.018809524
2022-02-23	Venpk102@jd.com							5		1	0.041666667
2022-02-23	Venpk107@jd.com				1458					1	1.62
2022-02-23	Venpk108@jd.com			231						1	0.165
2022-02-23	Venpk112@jd.com					113				1	0.226
2022-02-23	Venpk113@jd.com			14						1	0.01
2022-02-23	Venpk116@jd.com								244	1	4.206896552
2022-02-23	Venpk117@jd.com		2950							1	5.9
2022-02-23	Venpk119@jd.com					809				1	1.618
2022-02-23	Venpk121@jd.com			80				315		2	2.682142857
2022-02-23	Venpk124@jd.com			18						1	0.012857143
2022-02-23	Venpk125@jd.com						392			1	11.87878788
2022-02-23	Venpk127@jd.com				364	21	183			3	5.99189899
2022-02-23	Venpk129@jd.com					785				1	1.57
2022-02-23	Venpk130@jd.com			160						1	0.114285714
2022-02-23	Venpk132@jd.com					958			176	2	4.950482759
2022-02-23	Venpk134@jd.com							42		1	0.35
2022-02-23	Venpk137@jd.com						36	358		2	4.074242424
2022-02-23	Venpk138@jd.com					866				1	1.732
2022-02-23	Venpk14@jd.com					27				1	0.054
2022-02-23	Venpk140@jd.com					16				1	0.032
2022-02-23	Venpk144@jd.com						3	175		2	1.549242424
2022-02-23	Venpk146@jd.com		951	35						2	1.927
2022-02-23	Venpk150@jd.com					847				1	1.694
2022-02-23	Venpk151@jd.com							736		1	6.133333333
2022-02-23	Venpk152@jd.com			199		29			58	3	1.200142857
2022-02-23	Venpk153@jd.com					205				1	0.41
2022-02-23	Venpk154@jd.com				2027					1	2.252222222
2022-02-23	Venpk155@jd.com	4066				1204			10	3	6.452794745
2022-02-23	Venpk157@jd.com						323			1	9.787878788
2022-02-23	Venpk18@jd.com			421	22	573				3	1.47115873
2022-02-23	Venpk2@jd.com					135				1	0.27
2022-02-23	Venpk25@jd.com							1049		1	8.741666667
2022-02-23	Venpk28@jd.com	3679								1	3.503809524
2022-02-23	Venpk29@jd.com							13		1	0.108333333
2022-02-23	Venpk3@jd.com		2466						346	2	10.89751724
2022-02-23	Venpk30@jd.com					579	145			2	5.551939394

Table 6. Overall calculation

Based on the overall pivot table as the database, *Table 6. Overall calculation* is revealed and its summarized pivot table is listed in *Appendix B. Table 24. Overall calculation pivot table.* The calculation table aims to have an intuitive view of the mobility per operator per day and operators translated productive working hours. In this way, I can compare the average estimated actual working hours under each mobility circumstance and gain insights. In this way, the KPIs defined in *Table 2. KPIs and measurements* that involve 4. Mobility and 5. Effective working hours are applied to get insights into operators' performance. The expected standard productivity of each type of task is known and indicated at the top of *Table 6. Overall calculation,* based on this consensus, mobility and productive working hours of each operator can be calculated. Each actual productivity divided by each standard productivity gives the translated working hours per operator under each task, then we sum them up to gain the total translated productive working hours on the right column. The mobility literally counts the number of tasks per operator involved, a general summary of the calculation result is under *Appendix B. Table 24. Overall calculation pivot table.*

mobility	1		2022-02-23	2022-02-24	2022-02-25	2022-02-26	2022-02-27	2022-02-28
		total operators	41	40	29	19	17	36
		average productive hours	3.25	2.814	3.131	1.496	1.577	1.606
		total average productive hours	2.47					
		variance	11.40267385					
mobility	2		2022-02-23	2022-02-24	2022-02-25	2022-02-26	2022-02-27	2022-02-28
		total operators	17	11	12	8	12	19
		average productive hours	3.753	3.804	2.373	1.82	5.097	2.211
		total average productive hours	3.188					
		variance	7.197681512					
mobility	3		2022-02-23	2022-02-24	2022-02-25	2022-02-26	2022-02-27	2022-02-28
		total operators	7	3	5	5	1	7
		average productive hours	4.132	2.914	3.33	2.261	2.193	2.332
		total average productive hours	3.005					
		variance	5.517842501					
mobility	4		2022-02-23	2022-02-24	2022-02-25	2022-02-26	2022-02-27	2022-02-28
		total operators	0	1	1	1	1	0
		average productive hours	0.000	1.259	2.632	0.902	8.009	0
		total average productive hours	3.2					
		variance	10.83429682					
mobility	5		2022-02-23	2022-02-24	2022-02-25	2022-02-26	2022-02-27	2022-02-28
		total operators	0	0	0	1	0	0
		average productive hours	0.000	0	0	1.609	0	0
		total average productive hours	1.609					
		variance	N/A					

Table 7. Summary overall process

According to the overall calculation pivot table in the Appendix, I generate *Table 7. Summary overall process* above. It describes the number of operators recorded per day with corresponding calculated working hours. The mobility of operators can reach up to 5 which means one operator at most does five types of tasks per day. Through the result comparison, operators have the highest equivalent productive

working hours when the mobility is four. However, there are only four operators found under this circumstance in the sample date interval with a relatively large variance. This implies that the variance and uncertainty are considerable within the situation where one operator gets in touch with four types of tasks. We can observe that one of the operators completed the equivalent of 8.009 working hours on February 27 whereas other operators only had at most 2.6 hours. Therefore, this result of 4 types of tasks per operator is not convincible or reliable enough to suggest to the company. In contrast, when mobility equals two or three, the operators also have similar average productivity translated into working hours. Furthermore, the variance when the mobility is three is relatively small compared to other groups of data, hence it means the performance of operators is stable and consistent. As a result, I would say if JD Logistics controls the mobility of operators within the limit of three types of tasks at most can be done per operator, the operator performance can be improved with good efficiency.
For further investigation on the return process, I want to verify if the same mobility principle of the maximum of 3 types of tasks for the overall warehouse also applies to the Return department. The *Table 8. Return process calculation* and *Appendix B. Table 25. Return calculation pivot table* originated based on the return process. Here I only take return process-related tasks and operator performance into account, therefore, *Table 8. Return process calculation* follows the similar calculation formula as the overall calculation and the return calculation pivot table in the Appendix is an intuitive statistic of it. The mobility overview with translated productive working hours per operator is listed on the right column.

	type of task	return pre-inspection	return transfer	return put away		
	productivity(pieces per hour)	33	120	58		
time	name	return pre-inspectio	return transf	return put awa	mobilit	working hou
2022-02-23	Venpk100@jd.com		2		1	0.016666667
2022-02-23	Venpk102@jd.com		5		1	0.041666667
2022-02-23	Venpk116@jd.com			244	1	4.206896552
2022-02-23	Venpk121@jd.com		315		1	2.625
2022-02-23	Venpk125@jd.com	392			1	11.87878788
2022-02-23	Venpk127@jd.com	183			1	5.545454545
2022-02-23	Venpk132@jd.com			176	1	3.034482759
2022-02-23	Venpk134@jd.com		42		1	0.35
2022-02-23	Venpk137@jd.com	36	358		2	4.074242424
2022-02-23	Venpk144@jd.com	3	175		2	1.549242424
2022-02-23	Venpk151@jd.com		736		1	6.133333333
2022-02-23	Venpk152@jd.com			58	1	1
2022-02-23	Venpk155@jd.com			10	1	0.172413793
2022-02-23	Venpk157@jd.com	323			1	9.787878788
2022-02-23	Venpk25@jd.com		1049		1	8.741666667
2022-02-23	Venpk29@jd.com		13		1	0.108333333
2022-02-23	Venpk3@jd.com			346	1	5.965517241
2022-02-23	Venpk30@jd.com	145			1	4.393939394
2022-02-23	Venpk31@jd.com		2		1	0.016666667
2022-02-23	Venpk32@jd.com		40		1	0.333333333
2022-02-23	Venpk4@jd.com			217	1	3.74137931
2022-02-23	Venpk40@jd.com	277	20		2	8.560606061
2022-02-23	Venpk45@jd.com	180			1	5.454545455
2022-02-23	Venpk49@jd.com		474		1	3.95
2022-02-23	Venpk5@jd.com			59	1	1.017241379
2022-02-23	Venpk54@jd.com		339		1	2.825
2022-02-23	Venpk57@jd.com	375			1	11.36363636
2022-02-23	Venpk6@jd.com			65	1	1.120689655
2022-02-23	Venpk60@jd.com			283	1	4.879310345
2022-02-23	Venpk63@jd.com		29		1	0.241666667
2022-02-23	Venpk79@jd.com			197	1	3.396551724
2022-02-23	Venpk83@jd.com		363		1	3.025
2022-02-23	Venpk89@jd.com			101	1	1.74137931
2022-02-23	Venpk96@jd.com	511			1	15.48484848
2022-02-23	Venpk99@jd.com		16		1	0.133333333
2022-02-24	Venpk105@jd.com	503			1	15.24242424
2022-02-24	Venpk117@jd.com			357	1	6.155172414
2022-02-24	Venpk120@jd.com		57		1	0.475
2022-02-24	Venpk125@jd.com	53			1	1.606060606

Table 8. Return process calculation

The relationships between return operator performance and mobility are shown below in *Table 9. Summary return process.* For the duration of the chosen date, return process operators have the mobility at a maximum of 3 which indicates one operator had done three types of tasks at most. The equivalent productive working hours reach the peak at the mobility of 2 and have the most efficient productivity. In contrast, when operators' mobility reached 3, their productivity dropped down to the lowest compared to other mobility performance at the return process. Therefore, if the return process can set circumscription that the operators at most can process two types of tasks, then the operator performance is said to be improved. Compare with the maximum mobility of three constraints in the overall process, the Return department's limit at the mobility of two is feasible because the current return process only has three types of tasks which is way less than the tasks in the whole warehouse process. Therefore, the maximum mobility limit for the return process should be less than the maximum mobility limit in the whole warehouse. Hence, the conclusion on the mobility of 2 at largest for the return process is feasible and tenable.

mobility	1		2022-02-23	2022-02-24	2022-02-25	2022-02-26	2022-02-27	2022-02-28
		total operators	32	30	18	4	11	20
		average productive hours	3.835	3.702	3.963	2.248	1.955	1.997
		total average productive hours	3.257					
		variance	15.8					
mobility	2		2022-02-23	2022-02-24	2022-02-25	2022-02-26	2022-02-27	2022-02-28
		total operators	3	0	1	0	4	3
		average productive hours	4.728	0	1.277	0	7.622	1.84
		total average productive hours	4.679					
		variance	10.96					
mobility	3		2022-02-23	2022-02-24	2022-02-25	2022-02-26	2022-02-27	2022-02-28
		total operators	0	2	4	3	1	2
		average productive hours	0	1.533	2.357	2.414	1.277	1.84
		total average productive hours	2.05775					
		variance	7.74					

Table 9. Summary return process

4.2.2 Return order forecast

To investigate the forecast of return order quantity, I establish relationships between outbound orders and return orders. Return orders that we receive have to be processed outbound in our warehouse before so that they can be returned by customers and sent to our Return department again. Therefore, rules of thumb for the return rate of outbound orders need to be further researched and provide insights into the overall return forecast.

There are mainly two types of outbound orders in the warehouse, they are B2C and C2C respectively. B2C orders will directly be shipped to individual customers whereas C2C orders will be sent to the physical stores of Hunkemöller. A historical study on the outbound order quantity, as well as return order quantity, is shown in *Appendix C. Forecast.* In the table, all outbound and return-related data with two order types are recorded and summarized from June to December of 2021. The data is concluded in a format on daily basis, hence, the average order quantity result is calculated on the unit of orders per day. The outbound order proportion and return rate of each order type are calculated and drawn in histograms below (see *Figure 14. Outbound order proportion* and *Figure 15. Average return rate*).

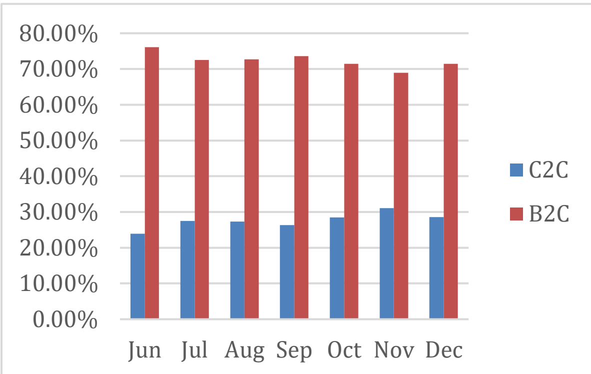

Figure 14. Outbound order proportion

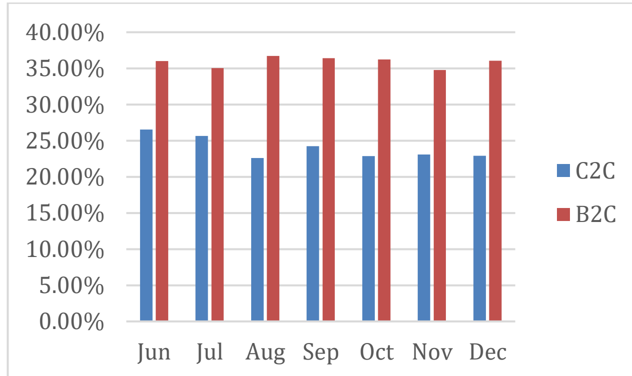

Figure 15. Average return rate

The results indicate that B2C orders have a larger scale than C2C orders at the outbound, the average B2C orders are 72.39% whereas C2C orders have a proportion of 27.61%. Similarly, the return rate of each type of order follows the principle that B2C orders are more likely to be returned than C2C orders. The average return rate for C2C orders is calculated at around 24% and for B2C orders 35.9%. With these numbers, I can estimate the rough number of return orders to be received on average per day.

*Return order quantity = C2C proportion * total outbound * C2C return rate + B2C proportion * total outbound * B2C return rate*
*= 27.61% * 24% * total outbound order quantity + 72.39% * 35.9% * total outbound order quantity*

However, this estimated return order quantity on average cannot assist forecast with precise because we have no clue which date of outbound data to use. The formula is given on the basis that the average monthly return rate is applied on a daily basis so that it can forecast the return order scale for next month if the outbound information of this month is known. If I divide this total forecast number by 30 days then average daily return orders to be received next month are obtained, but it is never accurate to specific days due to fluctuation neglected. If I want to forecast the quantity of return orders for tomorrow, then the question arises which date of outbound order quantity should I use? Therefore, a further investigation into the potential time interval correlation between outbound and return needs to be performed. In this way, I ensure the forecast of return orders is intelligent with reliability.

To develop further relationships between outbound orders and return orders, I randomly draw samples from January, February and March respectively. The selected dates are Jan 18th, Feb 16th and Mar 16th. For each date, their return pre-inspection historical data can be found and exported from the WMS system. I trace back from five to ten days before the pre-inspection date of receiving these return orders to see their outbound history and match the orders. In this case, I gain insights into the average days to receive return orders after outbound, the estimation of the quantity of return orders is visualized as well. *Table 10. Return and outbound order matchup* below illustrates the return order match rate for three chosen dates with respect to five to ten days difference. The customers' e-commerce orders need at least five days from outbound to return receiving considering the delivery companies' picking and delivery time. Therefore, the matchup of the outbound orders starts from five days ago and reaches up to ten days as my research time horizon. The matchup with the outbound orders is conducted by the VLOOKUP function in Excel by searching order numbers and detailed results are as follows.

return pre-inspection date	2022-01-18					
pre-inspected order qty	765					
outbound date	2022-01-08	2022-01-09	2022-01-10	2022-01-11	2022-01-12	2022-01-13
days difference	10	9	8	7	6	5
matched order qty	32	49	42	57	37	13
match rate	4.183%	6.405%	5.490%	7.451%	4.837%	1.699%
return pre-inspection date	2022-02-16					
pre-inspected order qty	981					
outbound date	2022-02-06	2022-02-07	2022-02-08	2022-02-09	2022-02-10	2022-02-11
days difference	10	9	8	7	6	5
matched order qty	22	67	85	87	45	33
match rate	2.243%	6.830%	8.665%	8.869%	4.587%	3.364%
return pre-inspection date	2022-03-16					
pre-inspected order qty	724					
outbound date	2022-03-06	2022-03-07	2022-03-08	2022-03-09	2022-03-10	2022-03-11
days difference	10	9	8	7	6	5
matched order qty	7	65	78	80	38	33
match rate	0.967%	8.978%	10.773%	11.050%	5.249%	4.558%

Table 10. Return and outbound order matchup

Align with the match rate results of outbound orders above, a line chart is formulated to visualize the return days with intuitive trends (see *Figure 16. Return order match rate*). It shows that return orders successively arrive at the warehouse five days after outbound and reach the peak on the seventh day. From seven to nine days after outbound, return orders maintain a stable match rate of around 10% and finally drop down after nine days of outbound. It indicates that most return orders will arrive at the warehouse and be accepted after seven to nine days of outbound. Therefore, the forecast of return orders for the day can be estimated as justified.

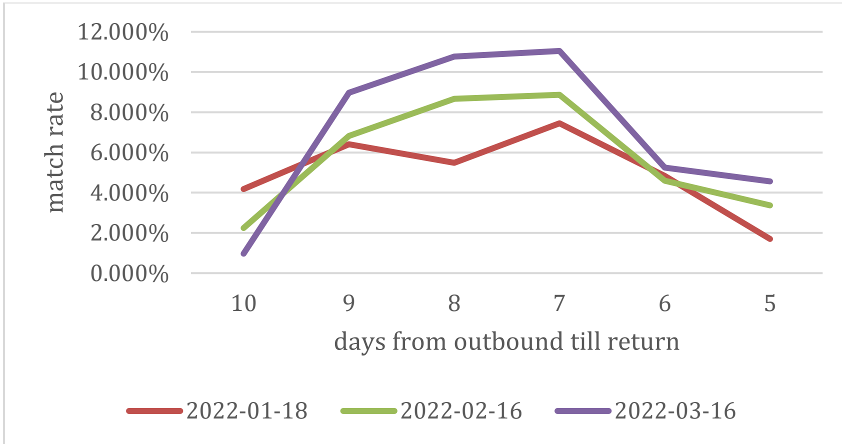

Figure 16. Return order match rate

Assume the company wants to know the expected return orders to arrive on day X, then the formula can be given as follows:

*Return orders on day X = 1/3 * [C2C return order on day (x-7) + B2C return order on day (x-7)] + 1/3 * [C2C return order on day (x-8) + B2C return order on day (x-8)] + 1/3 * [C2C return order on day (x-9) + B2C return order on day (x-9)]*

*= 1/3 * (27.61% * 24% + 72.39% * 35.9%) * [outbound order quantity on day (X-7) + outbound order quantity on day (X-8) + outbound order quantity on day (X-9)]*

For the consideration of the convenience for the company, I only count the peak return days which are seven, eight and nine as the main subject and furthermore assign these three days with an equal capacity of receiving orders. The 1/3 means three outbound dates arrive at the warehouse with the same return weight. Although the sample test shows the return rates of these days deviate and the Return department also receives orders from other outbound dates, the proportion assigned to 1/3 will on average fills and level up the shortage from other outbound days that I do not take into account. The proportion of each order type and return rate from previous calculations help formulate the accurate forecast formula. As a result, JD Logistics needs to make daily return order forecasts based on the historical outbound orders so that they can arrange proper resources for the return process without overstaffing or short staffing.

4.2.3 Resource allocation

In *Table 3. Measurement of performance* under Section 3.4.3, the estimated number of operators required to finish 1000 return orders for each task are given. In principle, the return process needs around 11 pre-inspection operators or 3 transfer operators, or 6 putaway operators to accomplish the same amount of work which is 1000 return orders. Hence, the allocation proportion for the return process should follow pre-inspection: transfer: putaway = 11: 3: 6 theoretically. To further verify the reliability of the principle, a quantitative analysis of the performance in practice is conducted. The *Table 11. Involvement of operators per task* below describes how many operators involve per task on the daily basis, the table uses the same data as the operator mobility research in Section 4.2.1. The average productive working hours, as well as variance, are listed along with the number of return orders received which supports the analysis. The KPI 5. Effective working hours that is defined in *Table 2. KPIs and measurements* is applied to get insights into operators' performance in this case.

date	pre-inspection	transfer	put away	avg working hours	variance of working hours	nr of products received
2022-02-23	17	10	11	3.912	12.01909599	2425
2022-02-24	15	6	9	3.702	17.6465769	1552
2022-02-25	10	4	7	3.822	11.43782637	1285
2022-02-26	0	2	3	2.247	1.664631782	0
2022-02-27	10	3	6	3.466	9.582761409	1052
2022-02-28	7	8	11	1.376	2.197533528	584

Table 11. Involvement of operators per task

According to the performance in practice, operators had high working hour performance in the first selected three days. The first day had the most productive operator performance. However, the received return orders quantity was almost twice as the second day and third day, normally operators need more time to handle and process excessive orders compared to the latter days. But the average productive working hours are basically the same as the second and the third day. This indicates the resource arrangement on the first day was not brilliant enough so labor productivity was not efficiently taken advantage of to reach its goal. Comparing the second day with the third day, the third day had fewer orders received but more productive hours. Furthermore, the variance of the working hours for the second day is relatively large and I must consider the instability it may occur if this arrangement is used. Therefore, the allocation pattern on the third day becomes most ideal among the first three days.

Looking at the last three chosen days, the fourth day does not have the feature of representative due to the fact that no return orders were received that day. The Return department perhaps only arranged the tasks for cleaning backlogs from previous days. The fifth day has a similar characteristic as the third day with acceptable variance, hence it is also regarded as an ideal resource allocation. Regarding the last day, although it has a low variance which indicates a high consistency of operator performance, the effective working hours are not optimal enough to say it is a reasonable arrangement.

As a result, both the third-day and the fifth-day arrangements are valuable to be defined as good resource allocations. If we look into the insights of both days, their human resource allocation proportion among tasks is all approximate to the theoretical optimal allocation proportion that pre-inspection: transfer: put away = 11: 3: 6. This implies that the Return department should follow the resource allocation guidance produced in accordance with the productivity of each task, in this way the Return department performance can be as efficient as possible.

4.3 Origin of solutions

4.3.1 Requirements

Here we discuss how the above solutions are generated. The MPSM proposes several setting requirements for solution generation and they become the rules that the company and I stuck to during the initiation phase. The following requirements for solutions are listed in accordance with the MPSM guidance (Heerkens & van Winden, 2016):

1. Validity
2. Comprehensiveness
3. Concrete
4. No interdependency
5. Possible to evaluate

The validity of solutions refers to the internal validity which is concerned with whether the solutions have been properly formulated and constructed. A valid solution should be able to solve the existing problem within the organization and finally contribute to the core problem. If the solutions represent the true findings in the research, we then ensure solutions are effective with good validity.

The solutions should also be comprehensive. Comprehensive means that the solutions have a broad scope. They should include every aspect of the subject of the research and cover the problems revealed. Once the causes of problems can be tackled in the solutions, the solutions are then diversified from different perspectives and can solve the final problem.

Solutions must be concrete in terms of content and problem-solving. They have to be clearly explained and well-structured to avoid any possible vague within concepts or during implementation. Solutions also should specify the research aspects that tackle so that organizations are aware of the population involved and strategy adjustment in the later implementation phase.

There should be no interdependency between solutions, each solution is dependent and can be implemented as an individual set. Any conflicts among solutions have to be considered and if solutions are bound together then that denotes solutions are no more feasible. With dependent solutions, we ensure they are all implemented in the next step because the company values all solutions equally.

The solutions finally need to be measurable in the evaluation to compare with the previous performance. The variables of solutions should be defined with operationalization, the evaluations reflect on different KPIs and a comparative method is applied. When solutions are measurable, we can evaluate them as good or bad in accordance with their outcome.

When designing solutions, the company and I followed the five requirements and generate solutions based on operation process as well as resource management strategy perspectives. The solutions are all dependent with concrete definitions, KPIs are connected to each solution so that they become measurable. There are mainly two channels where solutions are initiated: first, professional literature and scientific research offer practical solutions to my research-related questions. Based on these existing solutions, the company and I get insights, take advantage of their options and conceive to apply to our own case. We also involve creative ways of generating new solutions, brainstorming as the technique was widely used internally to produce solutions to the current problems.

4.3.2 Solution generation in practice

Cancel put-away containers

This solution is generated after a literature review session. Process integration is the requirement of smart warehouse operations management and functions as operational support in the framework (Zhen & Li, 2021). The objective of process integration is to achieve coordination while eliminating inconsistencies in business operation management. Van Gils et al. (2018) conducted research and revealed interactions among storage, batching and routing policies of the operation process within the smart warehouse. The result shows an integration of processes can attain remarkable benefits for the operation and overall warehouse. Therefore, process integration becomes our first topic in the field of operation processes and optimization. The pre-inspection process is considered to integrate with the transfer task so that the grade identification function can be bound within pre-inspection. No more transfer tasks are required in the operation process in this case and resources can be saved for other departments.

Pre-inspection information input

As an intern, I need to try every task of the return process in practice to get to know their functions and interrelations. During the practical operation at the pre-inspection, I found it rather complicated to switch between the RF scan, keyboard and mouse. Operators have to repeat this process from order to order and it becomes a time-wasting process for pre-inspection tasks. I asked for the opinions of the team leaders and colleagues from the Return department, they agreed that this process needs to be simplified to improve productivity. Then brainstorm sessions were conducted, finally we generated two methods which are full scan and partial scan. The full scan method converts all return order information into barcodes so that operators only need RF scanners to finish pre-inspection. However, to further improve the processing speed, a default setting is added as an alternative option according to the A grade return product proportion and this is what we call the partial scan. It remains the same as the full scan except for the grade selection with a default option.

Advance refund point

This solution is produced under brainstorming with employees from the Customer Service department of both JD Logistics and Hunkemöller. They as after-sales service departments, always receive complaints from customers that claim they have not received refunds. These considerable complaints come along with low customer satisfaction which will negatively affect the company’s image. A quicker refund process is required. Then we realized advancing the refund point in the system is an option without significant operation process change. The current refund point is founded on the completion of transfer tasks whereas the return process has already made sure all products are received after pre-inspection. Therefore, advancing the refund point to when pre-inspection of the return order is done is agreed between both JD Logistics and Hunkemöller.

Putaway to AGV zone

A literature review session helps to produce the solution of transferring from the manual putaway zone to the AGV zone which has a higher automation level. Equipment automation can increase warehouse productivity while reducing the need for manual labor. Zhen & Li (2021) introduce research into three catalogs including system analysis, design optimization and operational planning. In the case of JD Logistics, the company wants to focus on the operational planning aspect of the process and therefore the plan of maximizing the utilization of the current AGV is generated. The putaway task has the most generic functions for the return system compared with the current AGV zone functions. Moreover, putaway tasks have the most backlogs within the whole return system. Hence improving its productivity is prioritized compared to other return tasks. Therefore, it becomes our best option to remove the putaway task from the old manual area to automatic equipment.

Mobility

The mobility problem is recognized during daily monitoring of the warehouse performance. The supervisors noticed some operators' itinerants between tasks and have high mobility. The Return department manager was curious if this arrangement is reasonable with good productivity. Then the company looked into the performance of operators with high mobility and found out they have low productivity compared to other operators. But what can be the optimal mobility for operators to achieve the highest productivity? This becomes the research direction for the company in terms of resource management strategy.

Return order forecast

The current Return department has historical data on the average return orders received per day based on the time horizon of several months. However, this number cannot be considered as a forecast and has low accuracy due to the daily fluctuation. Research conducted by Kim et al. (2018) has proved intentional demand forecast bias can improve warehouse capacity planning and labor efficiency. The Return department get inspired by the demand forecast and the manager strongly agreed to design a new return order forecast function with high accuracy fulfilled. In this case, the return team leaders can arrange matched labor to avoid overstaffing or understaffing.

Resource allocation

Resource allocation as an integral part of BPM is important for efficiency improvement. A literature review session was performed for this solution generation. Huang Z et al. (2012) did research that took into account the effect of each task operation selection in the execution of a particular process case to suggest the overall optimal resource allocations in order to improve the global utility of the case. The Return department of JD Logistics also aims to improve the overall performance through logical resource allocation optimization. Therefore, it becomes one of the options for JD Logistics in resource management strategy adjustment.

4.4 Summary

This chapter includes solution generation and their ideations toward the problem. The solutions are generated based on the potential core problems which are operation process perspective and resource management perspective. The research questions and sub questions are answered as follows.

4. What are potential solutions to improve return efficiency?

As mentioned, solutions are generated based on operation processes and resource management strategies. Potential solutions from each aspect are listed:

Operation process aspect:

- Cancel put-away containers
- Advance the refund point
- Transfer putaway task to AGV zone
- Change the current pre-inspection information input method
    - Partial scan method
    - Full scan method

Resource management aspect:

- Control operators' mobility in the warehouse
- Forecast the return order numbers
- Arrange resource allocation reasonably

4a. What perspectives are to be considered while designing solutions?

Two main perspectives are defined as operation process and resource management strategies. The operation process should be intelligent with good convenience. The resource management strategies should be comprehensive with precise guidance. For the overall solutions, setting requirements are defined as constraints to generate solutions. Solutions should have validity to ensure they are effective Comprehensiveness makes sure all perspectives are considered and solutions are broad enough for problem-solving. Solutions should also be concrete with no interdependency. Finally, they are supposed to be possible to evaluate so that we know if they actually make improvements.

4b. What methods can be helpful for solution generation?

During the solution generation phase, two main methods are applied: literature review and brainstorming. A literature review session helps to gain insights into the existing solutions to see how other research used them to solve problems. Brainstorming among employees at the Return department and other departments contributes to better communication. We brainstormed new solutions for the specific problem in our warehouse and check the feasibility of implementation. Once the manager agrees to try new ideas, then we have new solutions.

5. Solution test

In this chapter, I present the implementation and evaluation process and answer the research question:

“How to implement and evaluate the chosen solution for the return process?”

In Section 5.1, the implementation phase is introduced about how operation processes are updated in practice. The evaluation of the implementation result is given in Section 5.2. This chapter verifies and gives insight into the feasibility of the solutions so that further recommendations can be made.

5.1 Implementation

Due to the time limit for the research, not all the designed perspectives can be implemented. Considering the priority and importance of the optimizations towards the research, the operation process becomes the most imperative perspective that needs improvements. JD Logistics also emphasizes operation process optimization more compared to resource management strategy adjustment. Therefore, only recommendations regarding the operator resource management will be made based on the investigation outcome in Section 4.2 instead of testing the validity of the solutions. Moreover, the systematic control of the process is more controllable compares to the unpredictable operator performance even under the guidelines. As a result, implementing operation process-oriented solutions becomes more solid with less risk and it is beneficial to JD Logistics.

Designed solutions in terms of operational processes are implemented individually. We do not set criteria and choose the best solution because on the one hand JD Logistics values the solutions equally and wants to implement them all to test the feasibility. In that case, the company has practical support for its future operational process innovation. On the other hand, all proposed solutions are dependent. These solutions are generated based on each task at the return process and do not bind each other so that the validity can be ensured, they can all be implemented without conflicts. Both information input methods are tested. It indicates that the partial scan and full scan methods get tested individually based on the old pre-inspection process. A cost estimation on the long run basis with productivity outcome on both input methods will be given after the test, therefore comparison can be conducted to decide the method with the superior outcome.

There are changes during the implementation phase to adapt the solutions, hence the warehouse layout for different function areas is adjusted accordingly as well. *Figure 17. New warehouse layout* shows an overview of what the warehouse function areas look like during the solution implementation.

While putting away return orders to the AGV zone, fractional original inbound stations need to be shared with return putaway tasks. In this case, the AGV zone becomes both the inventory area for normal inbound and return inbound. The blue area is still related to return processes, the difference is twofold: first, the old putaway zone now becomes the secondary putaway zone because return orders are on the shelf in the AGV area. However, it occurs when the normal inbound task is too excessive to spare inbound stations for the return process due to the priority of inbound tasks being higher than the return. The secondary putaway zone in this case plays a role in buffering return orders putaway so that pre-inspected orders avoid meaningless waiting and can be put away in time.

During the implementation of canceling put-away containers, the transfer station is replaced by the team leader table. In the new solution, the transfer task is no more required for the return process and the order complete task is outsourced and assigned to the return team leader to finish. I hope to mitigate operators' workload and save total operating time simultaneously. The team leaders then are capable to get insights into the performance and taking better responsibility for management in the meantime.

In other circumstance of implementing the refund point advancement and pre-inspection information input methods, the layout stays the same as the old warehouse layout in *Figure 7. Draft warehouse layout* because these two solutions do not require station replacements or transfer.

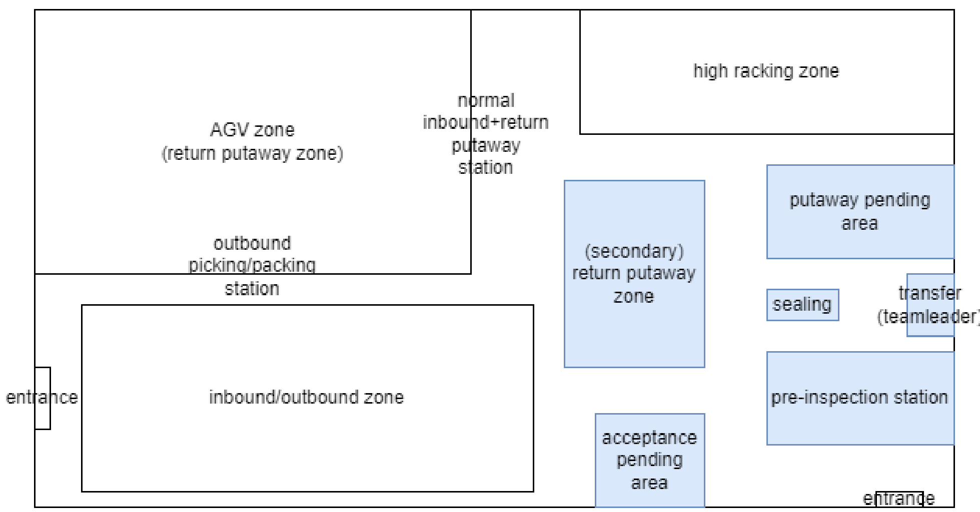

Figure 17. New warehouse layout

To construct a solid and clear image of process flow after implementation, *Figure 18. BPMN of implemented solution* reveals how the new return process with the physical and information flow look like when binding all proposed solutions together. Due to the dependency of each solution, they do not conflict with each other and can be implemented separately in practice.

When cancel the put-away containers, the new pre-inspection process starts binding directly with the transfer container with grade identification which differs from the old function. Then inspectors process the same steps as the old pre-inspection function. If the pre-inspected article has a different identified grade from the pre-bound transfer container, operators need to change the container to the correct container and continue repeating the pre-inspection. It is worth mentioning that the return team leader that replaces the canceled transfer station undertakes the responsibility of accomplishing order completion for the whole return orders in the WMS system. On the one hand, team leaders are expected to contribute to the process control as well so that they are aware of the status and make adjustments. On the other hand, inspectors at pre-inspection save operating time and efficiency can be elevated. The old grade identification function is integrated into the new pre-inspection concept, therefore, the transfer task does not exist anymore and fewer complications will significantly improve the overall efficiency of the return process.

When putaway to the AGV zone, the putaway task starts with scanning the A grade transfer container, as a small improvement, operators now only need to scan article barcodes as an initiation of the repetitive work till all articles in the container are scanned. In contrast, the old system requires operators to consistently scan put-away container numbers and then article barcodes to proceed. One step is deducted for each loop of the putaway task. Furthermore, previous putaway tasks can only be done through PDA whereas the implemented new solution can be conducted by both PDA and PC alternatively. Through experiment, two putaway devices have the same efficiency but operating based on a PC is more recommended. This is due to the fact that PDA does not acquire the ability to dredge troubles brought by abnormal cases. When extra articles appear or some articles missing in the transfer container, operators are more prone to solve them through a PC device so that they do not waste time waiting for help from team leaders. However, if the Return department chooses to open the putaway task to the secondary return putaway zone, only the PDA device can be applied. The tasks with orange background represent they can be processed with PC whereas a combination of purple and orange indicates tasks can be done both ways on PC and PDA.

The refund point is advanced to the time when pre-inspection is finished. I define this timepoint as the time when the order complete task is accomplished. In this case, customers are able to receive their money back in a shorter time compared to the old refund point. Customer satisfaction can be raised if the capacity for managing more refund orders increases as well.

The new information input methods will not apply to the new pre-inspection functions mapped below but follow the old pre-inspection steps in *Figure 8. BPMN of the current situation* because each solution has to make improvements based on the As-Is situation instead of the improved situation with other solutions.

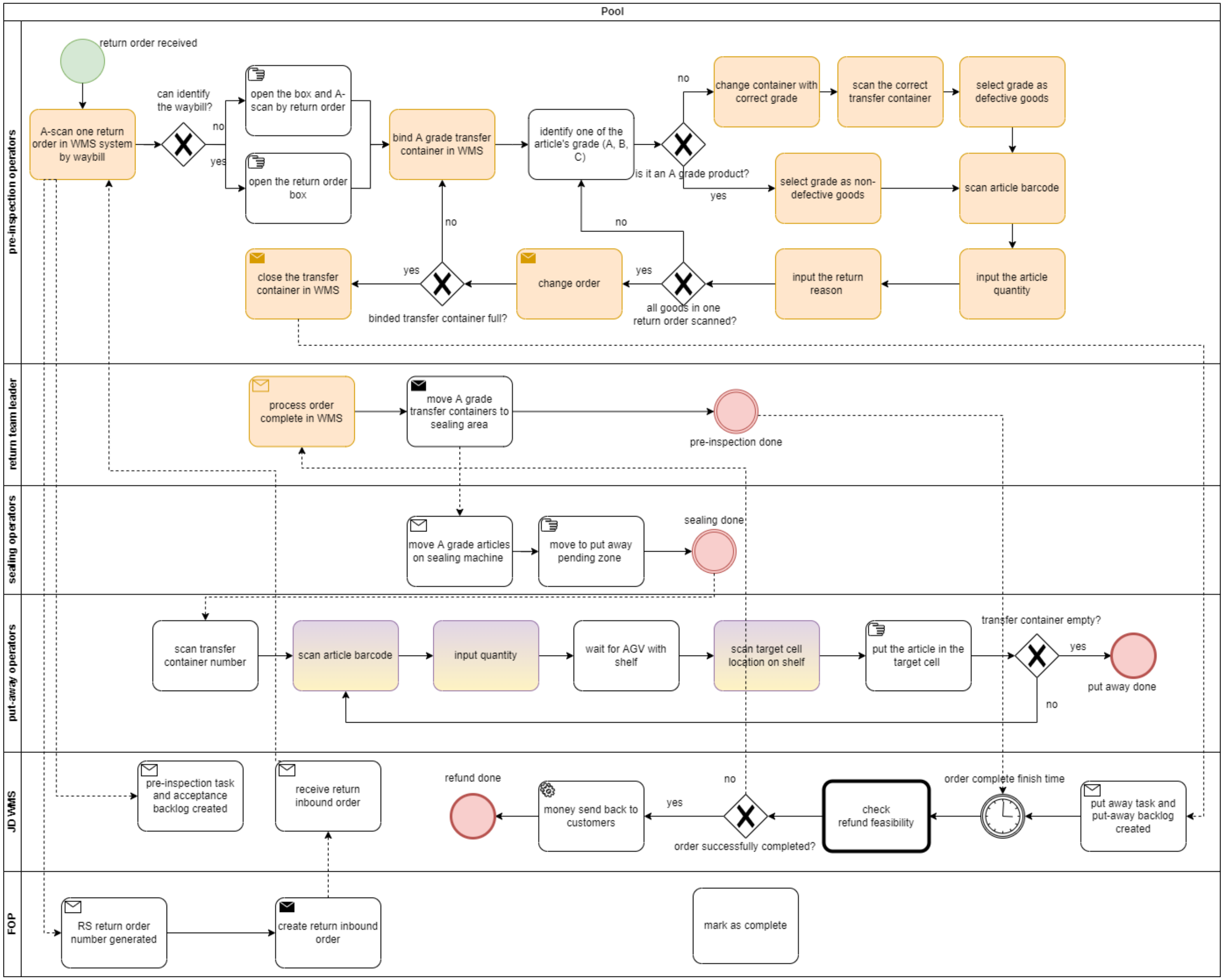

Figure 18. BPMN of implemented solution

5.2 Evaluation

5.2.1 Cancel put-away containers

After implementation of the optimized operation process, the transfer process is canceled, sealing process remains the same productivity because no further improvements are made at the sealing station. The pre-inspection process is significantly ameliorated. For pre-inspection, one operator now can finish inspecting 15 return orders per hour with the new function compared to the old function productivity of 11 orders per hour. The efficiency at pre-inspection increases by 36.4% with optimized processes. The overall productivity requires considering all processes and summing up the total working hours needed for each task to finish 1000 target orders. Final productivity is gained by using the target order number divided by the total number of people needed equivalent to the total working hours calculated. The overall return process productivity is calculated as follows in *Table 12. Productivity of cancelling put-away containers,* the putaway task and sealing productivity remains the same as the As-Is situation because no further actions on putaway and sealing are changed in this solution. The transfer task is canceled along with put-away containers. Finally, the overall productivity is rounded at 62 orders per operator per day.

target orders	1000	
working hour per people	8	
	productivity(orders/h/ppl)	working hours
inspection	15	66.66666667
Putaway	19.333333	51.72413882
sealing	93.75	10.66666667
total working hours(h)	129.0574722	
total people(ppl)	16.13218402	
total productivity(orders/ppl/day)	61.987887	

Table 12. Productivity of cancelling put-away containers

The refund point of this solution remains the same as the old system, hence the refund productivity stays unchanged. An overview of the KPIs of the old situation and new solutions as well as comparisons are listed in *Table 13. KPIs of canceling put-away containers.* As a result, the pre-inspection productivity increase by 36.36% whereas the overall efficiency presented by overall return process productivity increase by 38.18% when the put-away containers are canceled.

KPIs	Old situation	New solution
1. Productivity at each task (orders/ppl/h)	Pre-inspection: 11	Pre-inspection: 15 (↑ 36.36%)
	Putaway: 19.3	Putaway: 19.3
	Sealing: 93.75	Sealing: 93.75

2. Overall return process productivity (orders/ppl/day)	44.87	62 (↑ 38.18%)
3. Customer satisfaction (orders/ppl/day)	69.02	69.02

Table 13. KPIs of canceling put-away containers

5.2.2 Pre-inspection information input

During the implementation phase, the information input test is conducted individually in guidance with the old pre-inspection steps and with different information input methods. Other tasks remain the same as As-Is situation which means transfer, putaway and sealing are following the old mode. The old information input method in the pre-inspection process is defined as no-scan because when operators input article information within a return order, they need most manual input on the PC combined with a small part of the RF scan. I regard this way of working as unintelligent and hence define it as the no-scan method. The partial scan method leaves the article grade selection option as manual input on the PC device and replaces all other steps as the scan method. A default setting of "non-defective" is integrated with the partial scan method so that operators can mostly skip this step due to the large proportion of A grade products in return orders. In contrast, the full scan method applies all information input steps into the scan method including grade identification so that operators no more need to switch between keyboard and RF scanner. The results are shown in *Table 14. Productivity of the full scan method* and *Table 15. Productivity of the partial scan method* below. As observed, under new information input methods the pre-inspection productivities both increase which lead to higher overall return process efficiencies. The method for the partial scan has the most efficient operating process in that one operator can process 17 return orders per hour at pre-inspection and in total can finish 54.7 orders from pre-inspection to putaway on a daily basis. In contrast, one operator using the full scan method can finish 15 return orders per hour with 52 orders for the overall return process.

target orders	1000	
working hour per people	8	
	productivity(orders/h/ppl)	working hours
inspection	15	66.66666667
transfer	40	25
put away	19.333333	51.72413882
sealing	93.75	10.66666667
total working hours(h)	154.0574722	
total people(ppl)	19.25718402	
total productivity(orders/ppl/day)	51.92867238	

Table 14. Productivity of the full scan method

target orders	1000	
working hour per people	8	
	productivity(orders/h/ppl)	working hours
inspection	17	58.82352941
transfer	40	25
put away	19.333333	51.72413882
sealing	93.75	10.66666667
total working hours(h)	146.2143349	
total people(ppl)	18.27679186	
total productivity(orders/ppl/day)	54.71419752	

Table 15. Productivity of the partial scan method

An overview of the KPIs of the old situation and new solutions are listed in *Table 16. KPIs of new pre-inspection information input methods* below. The refund point and other tasks stay unchanged so their productivity is the same as the As-Is situation. It shows that the overall efficiency of the full scan increases by 15.9% whereas in terms of the partial scan, it increases by 21.9%.

KPIs	Old situation	Full scan	Partial scan
1. Productivity at each task (orders/ppl/h)	Pre-inspection: 11	Pre-inspection: 15 (↑ 36.36%)	Pre-inspection: 17 (↑ 36.36%)
	Transfer: 40	Transfer: 40	Transfer: 40
	Putaway: 19.3	Putaway: 19.3	Putaway: 19.3
	Sealing: 93.75	Sealing: 93.75	Sealing: 93.75
2. Overall return process productivity (orders/ppl/day)	44.87	52 (↑ 15.9%)	54.7 (↑ 21.9%)
3. Customer satisfaction (orders/ppl/day)	69.02	69.02	69.02

Table 16. KPIs of new pre-inspection information input methods

But is partial scan really the most optimal for the company compared with other scan methods? As elaborated in Section 4.1.2, due to the default setting of the partial scan method, quality control needs to be taken into account. To further investigate the credibility and verify the cost-effectiveness of the partial scan method, a labor cost forecast in a time horizon of years that involves different data input methods as well as quality control is conducted. In *Table 17. Overall warehouse productivity* the overall productivities for Inbound and Outbound departments are provided by JD Logistics.

productivity (per operator)	full scan	partial scan	no scan
pre-inspection （orders/h）	15	17	11
overall return process （orders/day）	52	54.7	45
overall inbound process （pcs/day）	4800	4800	4800
overall outbound process （orders/day）	141	141	141

Table 18. Overall warehouse productivity

The estimated annual outbound orders for the year 2022 are given by the company, with different growth rates applied in the future years, the order forecast till the year 2026 is calculated as follows (see *Table 18. Information input method costs*). The calculation of costs for each year follows the forecast orders and overall productivity of each department given in the table above. With order numbers and productivity of processing orders, the total working hours can be concluded, JD Logistics pays 23 euros to operators for each working hour and hence total labor cost is gained. It is worth noting that the productivity of overall inbound is given in terms of pieces of products that can be processed per day, but the order forecast is formatted in the order dimension. To unify and make it possible for calculation, statistics performed by the company show an outbound UPT of 4 which implies the total number of products for outbound as well as inbound per year on average is known because normal inbound quantity should equal outbound quantity to keep balance. Then I can calculate working hours at the Inbound department by translating annual orders into equivalent quantities of products and dividing by overall inbound productivity. Each input method follows its own unique productivity and costs are calculated below. Because of the default setting in the partial scan method, A-grade products proportion rises from 90% to 95% in all return products. One more quality control operator needs to be added to the Return department to monitor and double-check the pre-inspected products to avoid quality problems issued. Therefore, the cost for the partial scan plus one quality control person is also taken into account as a reference.

	FY2022	FY2023	FY2024	FY2025	FY2026
growth rate		0.2	0.15	0.1	0.05
annual order receive (orders)	1613155.5	1935786.6	2226154.59	2448770.049	2571208.551
no scan	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**FY2026**
annual labor cost	€ 3,810,976	€ 4,573,172	€ 5,259,147	€ 5,785,062	€ 6,074,315
partial scan	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**FY2026**
annual labor cost	€ 3,543,924	€ 4,252,709	€ 4,890,615	€ 5,379,677	€ 5,648,661
partial scan + quality control	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**FY2026**
annual labor cost	€ 3,692,857	€ 4,431,429	€ 5,096,143	€ 5,605,757	€ 5,886,045
full scan	**FY2022**	**FY2023**	**FY2024**	**FY2025**	**FY2026**
annual labor cost	€ 3,560,945	€ 4,273,134	€ 4,914,104	€ 5,405,515	€ 5,675,790
outbound order UPT=4; return order UPT=3; hourly rate paid to operators=23 Euros					

Table 19. Information input method costs

According to the labor cost results, the old input method which is marked as no scan has the most cost and is hence said to be not cost-effective. I calculate the cost savings of other scan methods based on the cost forecast of the no scan method to have an overview of which method is the most ideal. *Figure 19. Cost savings* depicts that partial scan has the most cost savings compared to all other methods in general. However, when a quality control person is required and added to the partial scan, the cost superiority vanishes and the full scan method becomes the most advantageous in terms of costs.

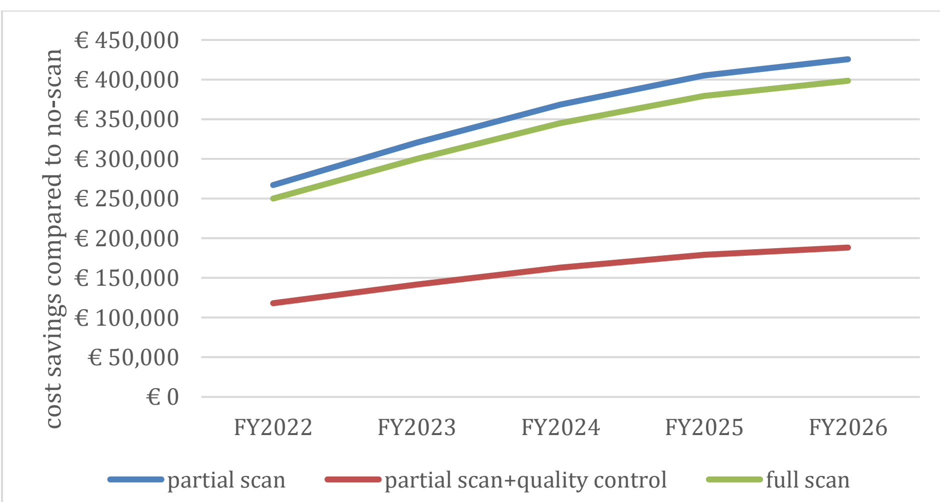

Figure 19. Cost savings

As a result, the full scan becomes the most optimal choice even if the partial scan has higher productivity in the return process. When quality control is associated with the partial scan method and has essential importance for the company in the overall pre-inspection, the productivity advantageous of the partial scan turns into quality inferior and finally reflects on a higher cost compared with the full scan method. Therefore, in terms of cost savings, JD Logistics should consider the full scan method since it does not require extra quality control staff to monitor the process. In this way, it saves the most labor cost for the company and hence becomes the optimal choice.

5.2.3 Advance the refund point

In the new refund point, the refund point is advanced to the time when pre-inspection is done instead of the old point when the transfer quantity equals the pre-inspection quantity. Therefore, the calculation of the new refund point productivity only needs to take the pre-inspection process into account since it is the sole variable that involves in the refund. The following *Table 20. New refund point productivity* describes the total working hours needed for one inspector to finish 1000 return orders. Then according to the consensus that operators work eight hours per day, the total number of people needed can be acquired correspond to the total working hours. I divide the 1000 orders by the total number of people needed to obtain the result that one inspector can process 88 return orders per day which indicates 88 return orders can be refunded per day by one inspector. Comparing the new refund point 88 orders with the old refund point 69 orders, the refund efficiency improves by 27.5%. This implies that more customers will receive their money back in a fixed amount of time, the customer complaints related to the slow refund process are considerably reduced and hence contribute to higher customer satisfaction.

target orders	1000	
working hour per people	8	
	productivity(orders/h/ppl)	working hours
inspection	11	90.90909091
transfer	40	0
put away	19.333333	0
sealing	93.75	0
total working hours(h)	90.90909091	
total people(ppl)	11.36363636	
total productivity(orders/ppl/day)	88	

Table 21. New refund point productivity

An overview of the KPIs of the old situation and new solutions as well as comparisons are listed in *Table 22. KPIs of the new refund point*. The productivity of each task and overall efficiency are not changed since only the refund point recognition in the system is advanced ahead and no actions on processes are made.

KPIs	Old situation	New solution
1. Productivity at each task (orders/ppl/h)	Pre-inspection: 11	Pre-inspection: 11
	Transfer: 40	Transfer: 40
	Putaway: 19.3	Putaway: 19.3
	Sealing: 93.75	Sealing: 93.75
2. Overall return process productivity (orders/ppl/day)	44.87	44.87
3. Customer satisfaction (orders/ppl/day)	69.02	88 (↑ 27.5%)

Table 23. KPIs of the new refund point

5.2.4 Putaway to the AGV zone

In terms of putaway, two types of new putaway functions are recorded and evaluated separately. As I mentioned, in the new putaway process, the putaway task can be done either in the AGV zone or the secondary putaway zone according to the situation. For the new putaway function at the secondary putaway zone which is also the original putaway zone for the old process, putaway productivity increases from 19.3 to 20 orders per hour for each operator. The growth rate for the AVG putaway zone has a higher increased from the old function of 19.3 to the current 23.3 orders per hour, 20.7% efficiency has been improved for the AGV putaway.

The overall productivity of the return process is differentiated into two types in accordance with the putaway method. Applying the new productivity of each task, the following calculations and results can be observed (see *Table 24. Productivity of the secondary zone putaway* and *Table 25. Productivity of the AGV zone putaway*). As a result, when putaway happens at the secondary putaway zone, the overall productivity is 45.3 orders per operator per day. in contrast, when return orders putaway is done at the AGV zone, the overall productivity becomes 47.2 orders per operator per day.

target orders	1000	
working hour per people	8	
	productivity(orders/h/ppl)	working hours
inspection	11	90.90909091
transfer	40	25
put away	20	50
sealing	93.75	10.66666667
total working hours(h)	176.5757576	
total people(ppl)	22.0719697	
total productivity(orders/ppl/day)	45.30633259	

Table 26. Productivity of the secondary zone putaway

target orders	1000	
working hour per people	8	
	productivity(orders/h/ppl)	working hours
inspection	11	90.90909091
transfer	40	25
put away	23.3	42.91845494
sealing	93.75	10.66666667
total working hours(h)	169.4942125	
total people(ppl)	21.18677656	
total productivity(orders/ppl/day)	47.19925171	

Table 27. Productivity of the AGV zone putaway

A summary of the KPIs is concluded in *Table 28. KPIs of putaway to AGV/secondary zone. Productivity summary* below. An intuitive observation of the improvement of the operation process reflected in productivity can be directly acquired. The refund point productivity for both putaway methods remains consistent as the old refund point. Both new operation processes based on secondary zone putaway and

AGV zone putaway have a better overall return process efficiency. But the overall return process efficiency improvements are not significant compared with other solutions.

KPIs	Old situation	Secondary zone	AGV zone
1. Productivity at each task (orders/ppl/h)	Pre-inspection: 11	Pre-inspection: 11	Pre-inspection: 11
	Transfer: 40	Transfer: 40	Transfer: 40
	Putaway: 19.3	Putaway: 20 (↑ 3.63%)	Putaway: 23.3 (↑ 20.7%)
	Sealing: 93.75	Sealing: 93.75	Sealing: 93.75
2. Overall return process productivity (orders/ppl/day)	44.87	45.3 (↑ 0.96%)	47.2 (↑ 5.2%)
3. Customer satisfaction (orders/ppl/day)	69.02	69.02	69.02

Table 29. KPIs of putaway to AGV/secondary zone

5.3 Summary

This chapter includes the implantation and evaluation of the chosen solutions. During the implementation phase, only solutions from the operation process perspective are implemented in practice due to the time limit of the research. As far as JD Logistics is concerned, operation process optimization has a higher priority than resource management strategy adjustment. They also value the solutions in the operation process equally and want to test them all. Therefore, operation process solutions are implemented and evaluated. The following research question and sub questions can be answered.

5. How to implement and evaluate the chosen solution for the return process?

The implementation of the solutions is under the supervisor of the Return department of JD Logistics. After sufficient communication and explanation with shift leaders and team leaders in the warehouse, they give instructions to the operators and monitor their performance. The evaluation of solutions is based on KPIs and data collection. Systematic statistics of data exported from WMS have to be analyzed through MS Excel functions. Evaluation of performance based on KPIs will result from the observed data and in form of graphs to support decision-making objectives. By applying the VLOOKUP to the data used in the WMS, the objectives on the respective level will be visualized within MS Excel. When we have calculated KPIs needed, we compare them with the performance of the As-Is situation and improvements can be revealed.

5a. What are the outcomes?

Under Section 5.2, results for each solution are listed with KPIs. We can observe that by canceling put-away containers, the productivity at the pre-inspection increases from 11 orders per hour per operator to 15 orders per hour per operator. Overall return process productivity increase by 38.18% from 44.87 to 62 orders per operator per day. The refund point advance solution increases customer satisfaction by 27.5%. The full scan method increases the pre-inspection productivity from 11 to 15 whereas the partial scan method improves the pre-inspection productivity from 11 to 17. The overall return process productivity increase by 15.9% and 21.9% respectively for these two methods. Putaway to AGV zone has a putaway task productivity improvement from 19.3 to 23.3 orders per operator per hour, the overall return process productivity increase by 5.2%.

6. Conclusions and recommendations

The action problem I defined is the low return process efficiency caused by poor human resource management and complex operation processes for JD Logistics. Understanding the current situation and measuring efficiency related KPIs is crucial to figuring out the bottlenecks to improve the overall performance. Section 6.1 answers the main research questions by answering the sub questions as conclusions. Recommendations are made in section 6.2 for JD Logistics in terms of resource management and operation process. Discussions that include limitation and further research direction is described in section 6.3.

6.1 Conclusions

Throughout this thesis, the main research question: how can operation process optimization and resource management improve the return process efficiency? Is answered by the following sub research questions.

1. What does the current return process look like?

Sub questions: 1a. How the physical and information flow of the current process structured?
1b. How is the current performance assessed?

Chapter 3. Current situation analysis discusses the warehouse layout, return process flow and performance measurement respectively. The current return process consists of four subprocesses which are pre-inspection, transfer, sealing and putaway. FOP and WMS systems are two main systems that are involved and widely used during the operation process. The physical and information flow of the return process is pictured in form of BPMN, interactions between each subprocess and systems are revealed as well. The measurement of performance is performed with KPI selection, the refund point and overall return process efficiency are defined and assessed based on the productivity of each subprocess.

2. What theories can be applied to improve process efficiency?

Sub questions: 2a. What is the theoretical framework?
2b. How does it help efficiency improvement?

I choose BPM as my theoretical perspective and BPMN as a tool to visualize the process flow. BPM emphasizes decreasing costs and increasing efficiency for organizations in the short term. This can mean more revenue and growth for companies. In the long run, BPM helps create competitive advantages by improving organizational agility so that companies become more flexible.

3. What problems are now existing in the Return department?

Sub questions: 3a. Who are the stakeholders for the core problem?

The core problems that exist in the current Return department are twofold: first, from the resource management perspective, operators have either high mobility among jobs or the return order forecast is not accurate enough. Both problems can lead to meaningless waste of working hours that the company needs to pay for, therefore, JD Logistics has a low profit margin. Second, the current operation process needs simplification and optimization. Customer satisfaction is low due to the late refund point that leads to the long refund term. The complex process not only results in low productivity but also causes abnormal cases with a higher possibility. As a result, operation processes and resource management need to be improved to realize a good efficiency in the Return department.

4. What are potential solutions to improve return efficiency?
Sub questions: 4a. What perspectives to be considered while designing solutions?
4b. What methods can be helpful for solution generation?

The solutions are designed from the operator performance and operation process perspectives. For operator performance, I investigate their historical performance and by using statistics, insights into the optimal arrangement are gained. The criterion while designing operator performance-related solutions follows mobility, return order forecast and operator allocation. From the operation process perspective, the refund point is advanced, put-away containers are canceled so that the transfer task is deleted. An innovative idea for the new putaway function to the AGV zone is proposed, the information input method at the pre-inspection is optimized with either partial scan or full scan method.

5. How to implement and evaluate the chosen solution for the return process?
Sub questions: 5a. What are the outcomes?

Only operation process solutions are implemented in practice due to the time limit of the research. All designed solutions for the operation process are implemented because they do not bind each other and are valued equally by the company. The outcome shows the new solutions can improve the efficiency of the overall return process and proved to be effective. The new information input methods also increase the productivity at the pre-inspection, however, when taking into the quality control and assessing in terms of labor costs, the outcome shows a different conclusion from the productivity analysis.

6.2 Recommendations

The recommendations for JD Logistics are also twofold from the resource management and operation process perspectives.

6.2.1 Resource management strategy

- A maximum task mobility of two at the return process and a maximum of three for the overall warehouse is suggested. During the investigation of the historical performance of operators, the effective working hours reach the peak when task mobility for operators in the whole warehouse is three. This means operators have the best and most stable performance if one person at most does three types of tasks in the warehouse. The same principle applies to the return process, operators are advised to do at most two types of tasks at the return process to achieve high efficiency.
- An accurate return order forecast should follow the outbound order quantity from historical days. The data trace shows that most outbound orders arrive at the warehouse as return orders equally

between 7 to 9 days after shipment. Furthermore, two types of outbound order types are recognized and their proportion of the total outbound orders can be gained. A relationship between each type of outbound order and their return rate is realized. Therefore, a forecast of return order quantity to be received on day x can be estimated by historical outbound quantity back to 7 to 9 days before.

- The operator allocation for the return process should follow the theoretical operators needed for each task to finish the same target orders. For the old operation process, the performance history shows when there are 1000 return orders, the closer the allocation proportion to pre-inspection: transfer: putaway = 11: 3: 6, the better efficiency the return process has. The ideal proportion comes along when productivity for each task is confirmed, their proportion of reciprocal which represents undertaking the fixed amount of work becomes the most optimal arrangement for the return process.

6.2.2 Operation process

- Deleting the put-away container is strongly recommended. The grade identification function for products that are endowed to the transfer task can also be embedded into the pre-inspection, in that case, we no more need extra transfer task at the return process and overall operation steps are simplified. According to the test result, this solution has the largest efficiency improvements among all proposed solutions and has the most potential during operation process optimization. A lot of working hours can be saved as well to increase the company's profit margin.
- Full scan method is advised to add to replace the current pre-inspection input method as the next iterative update. During the measurement of the input method productivity, the partial scan has the most ideal outcome. However, due to the default setting of the A grade identification function in the partial scan, the grade proportion in stock is highly likely to lose balance. As a result, quality control at pre-inspection needs to be considered while using the partial scan method. The final assessment shows in terms of costs, the partial scan has no advantage compared to the full scan when taking quality control into account. Therefore, the full scan input method at pre-inspection is advised to be included in the next generation of the return system improvement.
- Putaway at the AGV zone is a good option. The AGV zone has a better performance than the current putaway function in the human zone. To achieve high automation and reduce labor costs, the company should consider transforming into an intelligent way of working. However, compared with the overall return process efficiency improvements of other solutions, the AGV zone putaway solution has a relatively small improvement. Furthermore, AGV return stations are shared from the normal inbound station, it happens when normal inbound tasks are busy and hence have no vacancies for the return process. The return has to be shelved in this case due to its low priority rule. Considering the low priority and few productivity improvements of the new solution, JD Logistics is suggested not to choose this option at the present stage. The company can investigate more convenient and user-friendly putaway functions instead of binding with other departments that have higher priorities.
- The refund point can be advanced to when pre-inspection is done. The result shows that around 27.5% more customers can receive their refund in a fixed amount of time compared to the previous function. However, the overall return process efficiency is not improved because no actual processes are modified. Considering the benefits for the Customer Service department and also the image of Hunkemöller, this solution is suggested to be widely implemented in the future.

6.3 Discussion

6.3.1 Limitations

Limitations exist within the research. The time available for the thesis is limited to ten weeks so that not all designed solutions are realistic to be implemented and evaluated. Resource management related solutions are hence abnegated during the implementation phase compared with the operation process. Recommendations on operator performance are given based on the historical study and no further test in practice can prove the reliability and validity of the solutions.

Furthermore, although sealing is one of the processes in the Return department, there is no data recording of the sealing operator in the WMS or FOP system. Therefore, during the mobility investigation and any other operator performance investigation, sealing operators are not involved. However, this will barely affect the whole conclusion on resource performance since only one operator will work at the sealing machine per shift, and it will add no value to decision making due to this stationarity.

The data acquisition is subject to the permissions granted as an intern in the company. In the solution design of the resource management, historical data needs to be exported and analyzed. However, only a scale on the day dimension of data can be obtained which leads to potential inaccuracy of the sample test of mobility and resource allocation research. I did not observe the performance of other weeks during mobility performance analysis because the length of a week is used for investigating the mobility based on a daily basis. I can also choose the first day of each month and choose seven months as seven days in total, so it is a random sampling method with no relevance to other weeks. The data sample of return orders' trace and track used for resource forecast is based on the return history of three days. A broader sense of data scale ensures the correctness of the forecast conclusion given whereas three days basis may cause substantial deviation of results in future research.

6.3.2 Further research

To further verify the feasibility of the solutions proposed from the resource management perspective, further research should be conducted by the company itself. JD Logistics should implement the recommendations on the operators and evaluate the outcome to compare it with the previous performance. If the overall operator performance improves then I can say effective resource management can increase process efficiency as well with the same contribution.

Further research should also focus on abnormal case handling. The current process and system still lack proper track and trace function to find out the missing or dropped products. The current time spent on abnormal cases is regarded as a productivity loss and hence needs to be avoided.

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Appendix

Appendix A. Systematic literature review

The search database will be used are Scopus and Web of Science since they are the most trustworthy academic literature engine in my opinion. The systematic literature review is based on the research question: How does the chosen theoretical perspective contribute to the goal or problem-solving?

Number	Inclusion criteria	Reason for inclusion
1	Key words: BPM, Business process management, operation process, efficiency, process optimization, resource management	These key words are used as search terms and are most relevant to the knowledge question needs to be solved.
2	Subject: industrial engineering and management	Any study field that lies in the industrial engineering and management should be feasible for literature review purpose

Table 30. Inclusion criteria

Number	Exclusion criteria	Reason for exclusion
1	Non-English introduced articles	The language of the literature should be written in English
2	Beats Per Minute or other BPM terms not related to business process management	BPM stands for not only business process management, to ensure the accuracy of the review, other terms like Beats Per Minute should be excluded.
3	Finance	The finance field of study should be avoided and considered not relevant to my research.

Table 31. Exclusion criteria

Search database	Scope	Search string	Number of entries
Scopus	Article title, Abstract, Keywords	(“BPM” OR “Business process management”) AND "process efficiency" AND "resource management"	26
Scopus	Article title, Abstract, Keywords	(“BPM” OR “Business process management”) AND “process optimization” AND "efficiency"	12
Scopus	Article title, Abstract, Keywords	(“BPM” OR “Business process management”) AND "efficiency" AND "operation process"	3

Web of Science	Topic	(“BPM” OR “Business process management”) AND “process optimization”	48
Web of Science	Topic	(“BPM” OR “Business process management”) AND “resource management”	46
Web of Science	Topic	("BPM" OR "Business process management") AND "operation efficiency"	3
Total in Mendeley			138
Filter based on inclusion and exclusion			(-96)
Remove duplicates			(-26)
Remove after screening			(-9)
Final articles for research			7

Table 32. Search log

Number	Author	Title	Relevance
1	Mahir, Haračić; Kasim, Tatic; Merima, Haračić;	THE IMPROVEMENT OF BUSINESS EFFICIENCY THROUGH BUSINESS PROCESS MANAGEMENT	- Business process reengineering - Business process improvement - Business efficiency - Business process management
2	Reichert, Manfred; Lohrmann, Matthias;	Effective application of process improvement patterns to business processes	- Business process design - Business process intelligence - Business process optimization - Business process quality
3	Jean‐Philip, Pritchard; Colin, Armistead;	Business process management – lessons from European business	- Business process management - Organizational efficiency - Organizational change
4	Zdravkovic, Jelena; Shahzad, Khurram;	A goal-oriented approach for business process improvement using process warehouse data	- Business process management - Decision making - Process warehouse - Business process optimization
5	Huang, Zhengxing; Lu, Xudong; Duan, Huilong;	A Task Operation Model for Resource Allocation Optimization in Business Process Management	- Resource allocation - Business process optimization - Task operation model
6	De Ramon Fernandez, Alberto; Ruiz Fernandez, Daniel; Sabuco Garcia, Yolanda;	Business Process Management for optimizing clinical processes: A systematic literature review	- BPMN - Framework - Process optimization - Efficiency improvement

7	Lu Zhen; Haolin Li	A literature review of smart warehouse operations management	- Business process design - Operation management - Automation, integration, sustainability - Smart warehouse

Table 33. Final articles

Source number	Labor performance	Process control	Empirical study	Operation efficiency	Management strategy
1	X	X		X	
2			X		X
3		X	X	X	X
4	X		X		
5	X	X			
6			X	X	X
7	x		X	x	X

Table 34. Concept matrix

Appendix B. Mobility

date	name	sum: return pre-inspection	sum: return transfer	sum: return put away	sum: normal put away	sum: normal pre-inspection	sum: picking	sum: binning	sum: packing
⊙2022/2/23		**2425**	**3978**	**1756**	**24207**	**13298**	**1296**	**8673**	**8713**
⊙2022/2/24		**1552**	**4060**	**1751**	**8290**	**11030**	**917**	**8149**	**8283**
⊙2022/2/25		**1285**	**1925**	**1023**	**6439**	**4420**	**4727**	**15468**	**14138**
⊙2022/2/26			**492**	**414**	**198**	**4583**	**1073**	**12632**	**12995**
⊙2022/2/27									
2022/2/27	Venpk1@jd.com								535
2022/2/27	Venpk102@jd.com							2242	
2022/2/27	Venpk103@jd.com								1418
2022/2/27	Venpk110@jd.com	315	60						
2022/2/27	Venpk111@jd.com		46					2213	
2022/2/27	Venpk112@jd.com		350						
2022/2/27	Venpk117@jd.com				1494				
2022/2/27	Venpk118@jd.com								707
2022/2/27	Venpk119@jd.com								724
2022/2/27	Venpk122@jd.com	305							401
2022/2/27	Venpk129@jd.com								770
2022/2/27	Venpk130@jd.com						283		
2022/2/27	Venpk132@jd.com		93						762
2022/2/27	Venpk133@jd.com			174	971				
2022/2/27	Venpk137@jd.com								961
2022/2/27	Venpk146@jd.com						57		
2022/2/27	Venpk149@jd.com			119	1217				
2022/2/27	Venpk150@jd.com		38					1133	309
2022/2/27	Venpk155@jd.com			135	1148	718			1351
2022/2/27	Venpk160@jd.com							2974	
2022/2/27	Venpk29@jd.com		10						
2022/2/27	Venpk30@jd.com								1455
2022/2/27	Venpk32@jd.com	185	170						
2022/2/27	Venpk41@jd.com						155	904	
2022/2/27	Venpk54@jd.com						31	32	
2022/2/27	Venpk55@jd.com	180	47						
2022/2/27	Venpk57@jd.com		38						
2022/2/27	Venpk58@jd.com	3							
2022/2/27	Venpk6@jd.com								594
2022/2/27	Venpk78@jd.com				1950			896	
2022/2/27	Venpk91@jd.com	64	676						
⊙2022/2/28									
2022/2/28	Venpk1@jd.com								61
2022/2/28	Venpk10@jd.com								628
2022/2/28	Venpk102@jd.com							1433	
2022/2/28	Venpk103@jd.com	52							707
2022/2/28	Venpk105@jd.com		398						
2022/2/28	Venpk107@jd.com							1406	
2022/2/28	Venpk108@jd.com						1	231	
2022/2/28	Venpk11@jd.com								697
2022/2/28	Venpk110@jd.com								568
2022/2/28	Venpk112@jd.com								257
2022/2/28	Venpk113@jd.com						1	2189	
2022/2/28	Venpk115@jd.com								221
2022/2/28	Venpk119@jd.com	57	49						1029
2022/2/28	Venpk121@jd.com						289		246
2022/2/28	Venpk122@jd.com								597
2022/2/28	Venpk124@jd.com						100	593	207
2022/2/28	Venpk125@jd.com		961						
2022/2/28	Venpk127@jd.com	77							226
2022/2/28	Venpk129@jd.com							53	534
2022/2/28	Venpk133@jd.com				539				
2022/2/28	Venpk134@jd.com	4	10						25
2022/2/28	Venpk135@jd.com							2175	
2022/2/28	Venpk136@jd.com			137	154				
2022/2/28	Venpk137@jd.com		395						245
2022/2/28	Venpk138@jd.com	49							922
2022/2/28	Venpk139@jd.com			48				59	935
2022/2/28	Venpk142@jd.com								440
2022/2/28	Venpk144@jd.com	5						590	
2022/2/28	Venpk146@jd.com			200	451				
2022/2/28	Venpk149@jd.com			54	326				11
2022/2/28	Venpk152@jd.com						45		
2022/2/28	Venpk153@jd.com						538		
2022/2/28	Venpk155@jd.com		51		392				662
2022/2/28	Venpk159@jd.com				20	2144			
2022/2/28	Venpk16@jd.com								91

Table 35. Overall pivot table

operator under each date date	working hours under each mobility mobility: 1	mobility: 2	mobility: 3	mobility: 4	mobility: 5	sum: working hours
⊞ 2022-02-23	133.2525651	63.80133776	28.92395059			225.9778534
⊟ 2022-02-24						
Venpk105@jd.com	15.24242424					15.24242424
Venpk117@jd.com	6.155172414					6.155172414
Venpk120@jd.com	0.475					0.475
Venpk124@jd.com		1.02547619				1.02547619
Venpk125@jd.com	1.606060606					1.606060606
Venpk127@jd.com		12.59787879				12.59787879
Venpk130@jd.com	5					5
Venpk132@jd.com	1.92					1.92
Venpk135@jd.com			1.800349206			1.800349206
Venpk136@jd.com	1.096206897					1.096206897
Venpk137@jd.com	0.025					0.025
Venpk139@jd.com	0.234285714					0.234285714
Venpk144@jd.com	0.151515152					0.151515152
Venpk146@jd.com	0.061428571					0.061428571
Venpk150@jd.com	1.594					1.594
Venpk151@jd.com	16.275					16.275
Venpk154@jd.com		0.909571429				0.909571429
Venpk156@jd.com	0.791666667					0.791666667
Venpk157@jd.com		1.241714286				1.241714286
Venpk159@jd.com		6.507684729				6.507684729
Venpk16@jd.com	0.116					0.116
Venpk17@jd.com	0.708333333					0.708333333
Venpk18@jd.com	0.020714286					0.020714286
Venpk19@jd.com	0.06					0.06
Venpk2@jd.com	0.688					0.688
Venpk3@jd.com	0.2					0.2
Venpk32@jd.com	0.258333333					0.258333333
Venpk34@jd.com	4.965517241					4.965517241
Venpk39@jd.com	7.704					7.704
Venpk40@jd.com		2.191333333				2.191333333
Venpk41@jd.com				1.258714286		1.258714286
Venpk45@jd.com	0.672					0.672
Venpk49@jd.com	3.366666667					3.366666667
Venpk5@jd.com	3.896551724					3.896551724
Venpk53@jd.com			5.559761905			5.559761905
Venpk54@jd.com	0.308333333					0.308333333
Venpk57@jd.com	0.083333333					0.083333333
Venpk58@jd.com	0.393939394					0.393939394
Venpk59@jd.com	3.347619048					3.347619048
Venpk6@jd.com	2.810344828					2.810344828
Venpk63@jd.com	0.691666667					0.691666667
Venpk69@jd.com	6.482					6.482
Venpk72@jd.com	2.908					2.908
Venpk77@jd.com			1.380460317			1.380460317
Venpk78@jd.com		2.444689655				2.444689655
Venpk79@jd.com		6.826689655				6.826689655
[illegible]	[illegible]					[illegible]

Table 36. Overall calculation pivot table

operator under each date date	working hours under each mobility mobility: 1	mobility: 2	mobility:3	sum: working hours
⊟ 2022-02-23				
Venpk100@jd.com	0.016666667			0.016666667
Venpk102@jd.com	0.041666667			0.041666667
Venpk116@jd.com	4.206896552			4.206896552
Venpk121@jd.com	2.625			2.625
Venpk125@jd.com	11.87878788			11.87878788
Venpk127@jd.com	5.545454545			5.545454545
Venpk132@jd.com	3.034482759			3.034482759
Venpk134@jd.com	0.35			0.35
Venpk137@jd.com		4.074242424		4.074242424
Venpk144@jd.com		1.549242424		1.549242424
Venpk151@jd.com	6.133333333			6.133333333
Venpk152@jd.com	1			1
Venpk155@jd.com	0.172413793			0.172413793
Venpk157@jd.com	9.787878788			9.787878788
Venpk25@jd.com	8.741666667			8.741666667
Venpk29@jd.com	0.108333333			0.108333333
Venpk3@jd.com	5.965517241			5.965517241
Venpk30@jd.com	4.393939394			4.393939394
Venpk31@jd.com	0.016666667			0.016666667
Venpk32@jd.com	0.333333333			0.333333333
Venpk4@jd.com	3.74137931			3.74137931
Venpk40@jd.com		8.560606061		8.560606061
Venpk45@jd.com	5.454545455			5.454545455
Venpk49@jd.com	3.95			3.95
Venpk5@jd.com	1.017241379			1.017241379
Venpk54@jd.com	2.825			2.825
Venpk57@jd.com	11.36363636			11.36363636
Venpk6@jd.com	1.120689655			1.120689655
Venpk60@jd.com	4.879310345			4.879310345
Venpk63@jd.com	0.241666667			0.241666667
Venpk79@jd.com	3.396551724			3.396551724
Venpk83@jd.com	3.025			3.025
Venpk89@jd.com	1.74137931			1.74137931
Venpk96@jd.com	15.48484848			15.48484848
Venpk99@jd.com	0.133333333			0.133333333

Table 37. Return calculation pivot table

Appendix C. Forecast

Jun	type	AVG outcound order qty	outbound order proportion	AVG return order qyt	AVG return rate
	C2C	1478	23.92%	392	26.52%
	B2C	4701	76.08%	1694	36.03%
Jul	type	AVG outcound order qty	outbound order proportion	AVG return order qyt	AVG return rate
	C2C	1534	27.46%	393	25.64%
	B2C	4052	72.54%	1420	35.04%
Aug	type	AVG outcound order qty	outbound order proportion	AVG return order qyt	AVG return rate
	C2C	1180	27.28%	267	22.61%
	B2C	3145	72.72%	1155	36.72%
Sep	type	AVG outcound order qty	outbound order proportion	AVG return order qyt	AVG return rate
	C2C	1079	26.37%	261	24.22%
	B2C	3013	73.63%	1097	36.41%
Oct	type	AVG outcound order qty	outbound order proportion	AVG return order qyt	AVG return rate
	C2C	1446	28.52%	330	22.85%
	B2C	3625	71.48%	1313	36.22%
Nov	type	AVG outcound order qty	outbound order proportion	AVG return order qyt	AVG return rate
	C2C	2083	31.10%	481	23.07%
	B2C	4614	68.90%	1604	34.76%
Dec	type	AVG outcound order qty	outbound order proportion	AVG return order qyt	AVG return rate
	C2C	1466	28.59%	336	22.93%
	B2C	3662	71.41%	1321	36.07%

Table 38. Forecast table