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In-Company Project: Addressing Challenges in waste management - Reorganization of the evacuation process of Empty Plastic Boxes at an Amazon Fulfillment center.

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Master's degree in Management of Services and Technology

Supervisor:
PhD João Carlos Rosmaninho de Menezes, Associate Professor,
ISCTE-IUL

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BUSINESS SCHOOL

Department of Marketing, Strategy and Operations

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Resumo

A Amazon utiliza caixas pretas para transportar artigos vendidos em seu site entre seus armazéns, como o Centro de Distribuição LIL1. Uma vez vazias, as caixas precisam ser removidas e enviadas para outro local. No entanto, o processo de preparação e evacuação dessas caixas não é otimizado e gera muitas perdas para o site.

Um projeto foi lançado, aplicando conceitos de Lean Management e estratégias de implementação de mudanças para corrigir essa situação. O desenvolvimento deste projeto interno será detalhado nesta tese. Além disso, serão feitas observações sobre as técnicas utilizadas e as decisões tomadas para implementar essa solução, utilizando literatura relevante sobre Lean Management e implementação de projetos para melhor análise.

Conceitos e estratégias encontrados na revisão de literatura serão apresentados e discutidos, seguidos pela descrição da metodologia utilizada neste projeto. Com base nesses elementos, o andamento desta missão será analisado, destacando os desafios enfrentados, as soluções encontradas e sugestões sobre o que poderia ter sido feito de forma diferente. Conclusões sobre o resultado deste projeto e a aplicação desses conceitos serão apresentadas, com recomendações para futuras implementações e pesquisas.

Apesar dos desafios na aplicação de conceitos de Lean Management à logística, foi possível reduzir desperdícios e melhorar a eficiência no processo de evacuação das caixas vazias no LIL1. O apoio da liderança e uma comunicação clara foram essenciais para o sucesso deste projeto. No entanto, recomenda-se que pesquisas futuras se concentrem em setores de serviços ou logística.

Palavras-chave: Organização Interna, Comportamento Organizacional, Gestão da Cadeia de Suprimentos, Gestão de Inventário, Maximização de Lucros, Estratégia Competitiva
Classificação JEL: L21, M11, L22

Abstract

Amazon uses Black Totes to transport articles, sold on its website, between its warehouses, such as the Fulfilment Center, LIL1. Once the Totes empty, they need to be evacuated and sent to another site. However, the process to prepare these Totes for transport and their evacuation is not optimized and generates too much loss for the site.

A project was launched, applying Lean Management notions and change implementation strategies, to correct this situation. The unfolding of this in-company project will be detailed in this thesis. Additionally, observations will be drawn from techniques used and decisions made to implement this solution, using relevant literature, on Lean Management and project implementation, to better analyze them.

Concepts and strategies found in the literature review will be presented and discussed, followed by description of the methodology used during this project. Based on these elements, the unfolding of this mission will be analyzed, highlighting challenges encountered, solutions found and suggestions on what could have been done differently. Conclusions on the outcome of this project and on the application of these notions will then be drawn with recommendations for future implementations and research.

Despite the challenges in applying Lean Management notions to logistics, it could successfully reduce waste and improve efficiency to improve the evacuation process of Empty Totes from LIL1. Leadership support and clear communication were essential for the success of this project. However, despite the adaptability of Lean Management beyond manufacturing sectors, future research focusing on service sectors or logistics are advised.

Keywords: Internal Organization, Organizational Behavior, Supply Chain Management, Inventory Management, Profit Maximizing, Competitive Strategy

JEL classification: L21, M11, L22

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Glossary

AAs – Amazon Associates

BTs – Black Totes

Docks – Department responsible for the unloading of trucks coming to LIL1

East PT – East Pick Tower – where F Cell is located

EBTs – Empty Black Totes

FCs – Fulfillment centers

Flow – Department responsible for overseeing and coordinating other departments from Inbound or Outbound

Inbound – All departments related to the reception of articles at LIL1

LIL1 – Amazon Fulfillment Center at Lauwin Planque

LM – Lean Management

Outbound – All departments related to the expeditions of articles out of LIL1

Pick – Department responsible for collecting articles to be sent out of LIL1

PT – Pick Tower

School – Department responsible for training employees on activities realized at the FC

Shipping – Department responsible for loading and sending trucks out of LIL1

Stow – Department responsible for storing articles arriving at LIL1

TSI – Transfer In – articles coming from other Amazon centers

TSO – Transfer Out – articles sent to other Amazon centers

West PT – West Pick Tower – Where D Cell is located

Chapter I - Introduction

1.1.Background and Context

Lean Management (LM) derived from the Lean Manufacturing concept born in the beginning of the twentieth century with the company Toyota (Dekier, 2012). Contrary to Lean Manufacturing, LM is not limited to the production activities and regroup multiple notions, some of which will be treated later in this manuscript. The goal of LM is to improve a company's processes and ensure its competitivity (Lawal & Elegunde, 2020). Even though most of the academic articles analyzed for this study observed the actions of LM in a manufacturing context, its use can also be employed to the logistic environment of a marketplace platform such as Amazon. One of Amazon's main businesses is its online selling platform which requires the company to have multiple warehouses across the world, some of which are called Fulfillment Centers (FCs). Even though no production takes place there, numerous processes, machines, and items are necessary to ensure the activity of the company and the delivery of the products to the customers.

For this reason, despite FCs not being manufacturing facilities, they can encounter problematics and benefit from the utilization of LM tools, as suggested in the literature, where "Lean management is an approach to running an organization that supports the concept of Continuous Improvement, a long-time approach to work that systematically improves organizational efficiency and quality"(Saurah & Nishi, 2016, as cited in Lawal & Elegunde, 2020, p. 25), as organizations can be viewed in a general context and not solely in a manufacturing environment.

The LM system regroups multiple notions, some of which will be discussed in this study. However as not all of them are applicable in the context of the project discussed here, only the most relevant elements will be presented and discussed.

1.1.1. Amazon France's background

Amazon has been present in France for now more than 20 years. Through the years, the company has diversified its activity, offering music and video streaming services, creating software and informatic tools for other companies, or interactive machines, such as Echo's devices. However, it is mainly known for its primary activity of online selling platform. Amazon has created more than 35 logistical centers dispatched across France to store and distribute products sold on its platform, investing more than 20 billion euro between 2010 and 2022 in the country (Amazon, 2024).

When the project, described in this study, was realized, Amazon France had already implemented multiple notions of LM that will be discussed later. This situation simplified the realization of this mission and will be considered when observing the realization of the project.

1.1.2. Project's context

Amazon uses Black Totes (BTs) to transport articles between its various FCs but also inside its sites. Departments, there, are divided into two parts, the Inbound which receives and stores the articles in the FC and the Outbound which sends these articles to clients or other FCs. At LIL1, the FC concerned by this project, BTs arrive through the Docks, the department receiving products to be stored in the center. The articles in these BTs are then stored in one of the two storage areas of the site, called Pick Tower (PT), by the Stow department. These two areas are called the East PT and the West PT. Once empty, BTs are collected, piled and put on pallets. These pallets are then transported to another part of the FC, called the A Cell to be circled (plastic bands are put around these BTs to secure them on the pallets) stacked up (a pallet is piled on another one to optimize their transport and storage) and circled again to secure both pallets. The route taken by these Empty Black Totes (EBTs) to the A Cell vary depending on the PT they come from (cf. Annex A). Some paths contain more steps for the processing of these elements. While the path originating from the West PT needs multiple trips with a forklift, the ones from the East Pt needs for the pallets to be put in a trailer, go out of LIL1 and reinter the FC to access the A Cell.

Once these EBTs have been processed in the A Cell, they are stored in this area, and trucks are ordered to evacuate them from the site. Once the transport vehicles are there, they are moved to the trailer and evacuated from the FC.

The graphic below, summarizes the path of EBTs at LIL1.

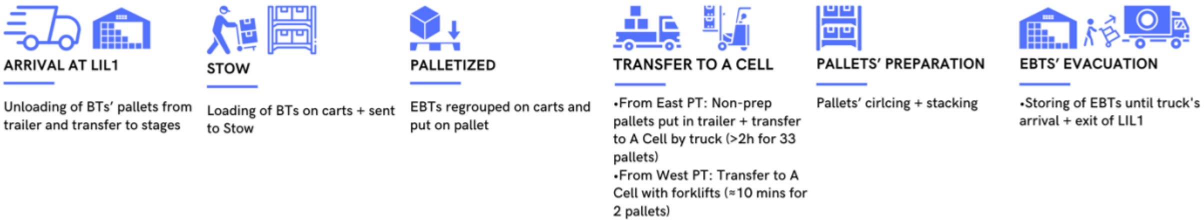

Figure 1.1: Evacuation path of EBTs at LIL1

As this process is quite lengthy and cumbersome, involving multiple Amazon Associates (AAs) and needing a high number of hours (in average 59h per week for each PT), a project to find improvement ways for this was launched. Challenges were met during this mission and solutions were found to improve this evacuation process. These points will be developed later, in this manuscript.

1.2.Research Problem and Objectives

This study has for objective to observe the project carried out at the Amazon's FC, LIL1. This observation will be through the description of its execution and elements such as its purpose, the challenges encountered, the decisions taken, the results obtained, the environment and context, the data found and how they were processed. This manuscript also has for objective to reflect on this project. To do so, these elements will be discussed to determine if this project could have been carried out differently and potentially better. The application of LM in a logistic environment, such as warehouses where no production takes place, but tasks can still be optimized for greater efficiency, as well as the implementation of changes will also be observed and analyzed.

Moreover, this study will highlight specific challenges faced when applying of LM principles and implementing changes, during the realization of this mission. These challenges will then be discussed and analyzed with insights provided by academic literature to understand how they have been addressed in similar contexts and what lessons can be drawn from this project. In resume, this study will aim at answering the following problematic: How can the evacuation of EBTs at LIL1 be optimized and what challenges must be overcome through leadership, communication, and stakeholder collaboration to ensure its successful implementation?

In order to answer this problematic, the development and implementation of the project, as well as the results observed from applying the proposed solution, will be detailed. In addition, the challenges and situations encountered will be discussed in consideration of LM principles viewed in academic reviews to identify areas where practical applications align with theorical notions. This approach will help in better understanding what was done during the realization of this project, and what can be learned from this project to develop a better approach of LM principles and project implementation methods in the future. For this reason, this study will also intend to discuss what could have been done differently, or better and what will be needed, in the future, to ensure the continuity of this project and its effectiveness to improve this process on the long term.

Through this manuscript quantitative metrics used to find and implement the solution will be detailed. In addition, qualitative aspects of the project, such as the communication methods and their effectiveness with stakeholders as well as the role of leadership and top management when implementing new practices and applying LM principles in a company, will be observed and discussed to ensure a complete view of this mission's context and realization. The needs and effects of employees' involvement as well as their motivation in these circumstances will also be addressed through this manuscript.

In this manuscript, the handling of the project will be discussed through various sections. A first section will address how data were collected, processed, verified and presented. It will mainly focus on quantitative metrics. A second section will discuss the managerial aspects of the project, observing the challenges encountered during its realization and drawing lessons from the techniques used and decisions made. This part will focus on qualitative observations and findings from academic reviews on LM and project implementation. Following these, the project's detailed implementation will be presented, detailing the project realized in a chronological order. This endeavor aims at providing a complete view of the project, the context surrounding its realization, its purpose, the tools and elements used to find and implement the solution… It also aims at learning from this experience, highlight practices that seemed well done and what could have been done differently or better.

1.3.Value of the Study

This study aims at contributing to the academic field but also to practical industry applications. Additionally, it seeks to provide deeper insights into the application of Lean Management and project implementation strategies that can benefit future research and professional practice.

Through this research, practical insights into the application of LM principles within a real-world context, such as at LIL1, an Amazon FC, will be observed. This work intends to observe how LM strategies can be effectively adapted and implemented in logistic practices, serving as a valuable resource for scholars and professionals searching to deepen their understanding of LM notions.

The identification and categorization of specific challenges faced during the implementation of this project and the application of LM practices, participate in providing a better understanding of current literature on LM concepts and change implementation within a logistic environment. Detailed examples of obstacles along with solutions from the project led at the Amazon warehouse are given and discussed in this study, highlighting the importance of context in the success or failure of lean initiatives.

The critical role of stakeholders' collaboration in the successful application of LM practices is highlighted there. The study demonstrates how the involvement of various stakeholders, such as associates, leads, area managers, and operation managers, can lead to more effective and sustainable solutions. Moreover, the challenges of change application and management are addressed, there, offering valuable insights on how to obtain stakeholders' involvement and motivation, as well as mitigate resistance to change. This research contributes to the qualitative literature on LM through the description of the project's various steps and milestones leading to the implementation of a solution. It provides a rich, contextualized account of the challenges and solutions in resource management, making it a valuable reference for future studies.

The focus on logistics and service industry brings additional references for the application of these notions, in a sector other than manufacturing, offering insights that are relevant to high-volume, fast-paced environments.

Overall, this work not only discuss the improvement of EBTs' evacuation at LIL1 but also enhances the understanding of LM application and offers actionable insights that can help organizations improve their processes and achieve greater operational efficiency.

Most of the analyzed articles related to LM, observe its application for manufacturing environment. This article aims at providing another perspective to the application of LM principles, complementing already existing resources, which is not related with the creation of products or value-added activities but more with support processes.

Chapter II - Literature Review

2.1. Lean Management

LM derives from the Toyota's production system, Lean Manufacturing, from the beginning of the twentieth century (Salonitis & Tsinopoulos, 2016) and (Dekier, 2012).

According to academic reviews, LM, a socio-technical system, aims at eliminating waste (Baides & Moyano-Fuentes, 2012). To do so, customer, suppliers and internal variabilities are to be reduced and even minimized. Some articles also offer a more general definition of LM, stating that it is "a method of managing companies that assumes adaptation to the actual market conditions via organizational and functional alternations" (Dekier, 2012). While other define this notion through a different angle, explaining that this approach supports the Continuous Improvement of an organization to systematically improve its organizational efficiency and quality (Lawal & Elegunde, 2020).

Even though all these definitions may vary in scope or specificities, main ideas subsist. LM is a system of business management aiming to improve its efficiency by reducing, minimizing or even eliminating non necessary elements from its activities.

These elements to be eliminated are qualified as waste since they do not add value to the product or service and are considered useless (Helmod, 2020). This notion of waste elimination is also often associated with the notion of Lean Thinking as it serves the same purpose as LM (Dekier, 2012). However, contrary to LM, which is a philosophy, Lean Thinking is more a frame of mind which can be considered but not necessarily fully implemented in a company's organization. Lean Thinking is the methodology originating form Toyota's Lean Manufacturing and leading the mains guidelines of LM (Elnadi, Shehab, & Peppard, 2013).

The notion of waste being an important component of Lean Thinking and LM, many scholars have worked on defining and analyzing it. The term Muda has emerged and has been commonly used to refer to these wastes (Grzelczak & Werner-Lewandowska, 2016). Yet, this concept being vague as it is, multiple delimitations of its meaning have been brought by academics. However, the majority of analyzed articles concur that waste can be defined through the value that can be added through a process' steps (Elnadi, Shehab, & Peppard, 2013). Activities that do not bring value to a product or service are considered as waste (Kadarova &

Demecko, 2015). Academic literature, precise that waste can be waiting times between value-added activities, scraps or reworks resulting from excess variability or unnecessarily long cycle times (Salah, Rahim, & Carretero, 2010).

A more specific delimitation of what is considered waste in a company is provided by other scholars by stating that they can be organized in seven categories: transportation, motion, overproduction, inventory, waiting, defects and over-processing (Ramkumar, Dr. Satish, & Venugopal, 2019). These categories can be defined as presented below (Grzelczak & Werner-Lewandowska, 2016):

- Transportation is due to unnecessary long distances between production processes leading to time loss, additional costs and higher risks of damage during the transport process.
- Motion is affiliated to unnecessary movement stemming from poor jobs and production' organization, leading to more steps, tasks and movement for workers.
- Overproduction is the result of producing more than what is demanded from the market.
- Inventory is the stockage of too much raw material or finished goods, which is related to the overproduction. This generates additional storage costs, provides no value to the company, as it is not sold yet, and costs capital.
- Waiting is related to bottlenecks and the impossibility for employees or machines to execute their job as they are waiting for products to come from the previous process, costing money but incapable of bringing value during this waiting period.
- Defects is the result of making too many defective products, which have to be discarded, or create additional costs to be repaired.
- Over-processing can be caused by improper design of the production line or technologies' selection adding additional work for the employees, without adding value for the customer.

An eighth category of waste is added in viewed literatures, which is talent waste, corresponding to the incorrect use of employees' potential or qualifications (Kadarova & Demecko, 2015).

Despite wastes being organized in these specific categories, they are dependent on each other (Ramkumar, Dr. Satish, & Venugopal, 2019). For instance, employees needing to do too many unnecessary movements and trips to execute their job might process less product than their colleagues, leading to the creation of a bottleneck at his level, ensuing in the inactivity of the people for the following process, and waiting time. In this example, wastes affiliated to motions, transportation and over-processing issues can then lead to a waiting one.

The majority of the literature analyzed, observe the application of LM principles through a manufacturing and direct processes angle, basing their definitions on the direct creation of products. However, these principles can also be applied to service or logistic contexts, and for support activities, as it will be discussed through this study. This lack of resources on non-manufacturing organization was also noted when talking about Lean Thinking (Elnadi, Shehab, & Peppard, 2013). They stated that despite the importance of this methodology to services, "there is yet a lack of empirical research examining the possibility of applying lean thinking in Product-Service System" (Elnadi, Shehab, & Peppard, 2013, p. 461). Through this paper, it was also confirmed that LM notions could be applied to other sectors, stating that "lean approach can be applied to services" (Elnadi, Shehab, & Peppard, 2013, p. 462).

Nevertheless, as services do not create products, some of the waste categories from the Muda theory, described previously, might not be relevant in this scenario. For instance, Overproduction or Inventory issues are more difficult to apply there. Other categories might be relevant but in different ways than for manufacturing organizations.

Due to the scope of the project described in this manuscript, a higher focus will be dedicated to the Transportation and Motion issues.

2.2. Projects and changes Implementation

LM principles discussed above imply a need for the Continuous Improvement of a business in order to perfect its system and minimize wastes. Multiple studies link the notion of Continuous Improvement with the term Kaizen and the Lean Six Sigma.

Kaizen is a Japanese term meaning Continuous Improvement (Grzelczak & Werner-Lewandowska, 2016). It is a philosophy of management in which improvement is at its core. This improvement has to be unceasingly, systematic, involving all employees and implemented step by step.

Lean Six Sigma is a strategy focused on process improvement, in particular to better quality as well as to reduce time and cost, among other elements (Alnadi & McLaughlin, 2020). This methodology derived from the association of lean principles, presented above, with Six Sigma. The Six Sigma methodology focuses on the obtention of high level of quality (two defects per billion opportunities) while reaching low levels of variability (Salah, Rahim, & Carretero, 2010). Authors from analyzed literatures affirm there is a clear connection between Lean and Six Sigma as the notion of waste can also be assimilated with the scraps and reworks resulting from excess variability in the processes, as it was previously detailed among the seven categories of waste (Salah, Rahim, & Carretero, 2010). This statement link then Lean Six Sigma with the aim of eliminating waste in the organization. Moreover, according to other scholars, Lean and Six Sigma are highly popular for the enabling Continuous Improvement in companies, linking these two notions even more (Saja & Jiju, 2013).

Even once fully implemented in a company, these notions require regular changes among processes and the implementation of new projects. Multiple studies analyzed agree that the implementation of changes in an organization requires a strong involvement from the leadership (Salonitis & Tsinopoulos, 2016; Kadarova & Demecko, 2015) and a high level of communication (Puvanasvaran, Megat, Hong, & Razali, 2009; Alnadi & McLaughlin, 2020).

According Anagnoste et al. (2016), the management of a company can become a driver of a barrier to the implementation of lean strategies, depending on its behavior and its support toward lean actions. This idea is also corroborated by Salah et al. (2010), saying that because effective implementation of notions, such as Six Sigma, relies on the interest of top leadership in their support, their commitment is essential for its success. It is advised that this support is also accompanied by training and assistance, as stated for the application of Lean Manufacturing. According to De la Vega et al. (2023) "A direct correlation exists between the efficacy of leadership in adopting Lean Manufacturing and said leader providing comprehensive training and assistance to employees." (p. 4). The study also qualifies leaders as playing a pivotal role in the initiation of change in a business. Kadarova and Demecko (2016), add that LM requires strict discipline and managers with vision.

The lack of such leadership can lead to major challenges in the implementation of Lean. Additionally, clear communication is important as the absence of it can also lead to challenges in the application of Lean strategies (Elnadi, Shehab, & Peppard, 2013). Leadership should clearly communicate the implementation goals of LM and trigger employees' interest (Maware & Parsley II, 2022).

Muszynska (2015) wrote that leadership styles should be appropriate for the management of teams. Leaders need to adapt their approach to their team and their interlocutor to ensure the best communication conditions, motivate them and ensure the effectiveness of the project's implementation (Alnadi & McLaughlin, 2020). There is not one universal way to do this, and it is important to adapt to the situation and person. As stated in this article, leadership styles can be broken down as below:

- Situational leadership: when the behavior changes according to the situation, relation-oriented or task-oriented.
- Transformational leadership: when leaders inspire their employees through the mean of four factors: charismatic influence, inspirational motivation, intellectual stimulation and individualized consideration.
- Transactional leadership: when clear objectives are set and punishment as well as rewards are used to encourage employees to reach them.
- Servant leaders: when employees' needs are the priority, they are coached and supported to optimize their performances.
- Authentic leadership: when leaders are true to themselves depending on their own standards and values instead of reacting to external pressions.
- Empowering leadership: when leaders give power to employees by sharing their authority and responsibilities with them or by increasing their motivation and removing the feeling of helplessness.
- Distributed leadership: when there are multiple leaders with various tasks sharing relations to each other and leadership is seen more as a practice than a responsibility.

Through the majority of analyzed studies and the leadership styles described above, communication is often stated as being of great importance for the implementation of changes, the continuity of LM's notions or the realization of projects. As employees play a crucial role in these aspects (Baides & Moyano-Fuentes, 2012), they will be the ones applying these practices and facing these changes, most of the time, it is important to keep them informed and communicate efficiently with them, as it is for the leadership to provide its support. It is important for leadership to show and communicate their commitment to implementing the project. It is even said to be vital for the success of this operation. This action permits to generate interest in this endeavor and ensure that all the organization is aware of the changes (De la Vega, et al., 2023). Puvanasvaran et al. (2009) even goes further, stating that top management should create interest in the change, in addition to communicating it and showing their commitment.

Multiple articles highlight that the lack of communication or its improper use can lead to the creation of challenges, when realizing and implementing a project in an organization. Especially during the implementation phase, the lack of this element from the leadership can lead to a significant challenge (Elnadi, Shehab, & Peppard, 2013). The priority for the leadership is to correctly communicate the purpose of this change (Maware & Parsley II, 2022) but also to transmit the guidelines for this project to the team in order to ensure its smooth unfolding (Saja & Jiju, 2013). Multiple papers highlight the importance of a clear and well communicated strategic plan. The strategic framework for these changes should be centrally coordinated and followed by the top management (Elnadi, Shehab, & Peppard, 2013). Maware and Parsley II (2022), for instance, explained that the purpose of Lean implementation processes can be missed by employees if there are no strategic plans in place. They also added that this situation can lead to their resistance to other changes when performing their operations. The reasons for the changes and its vision should then be clearly communicated, the goals, as well as the strategy well defined and expressed. Failing to do so can also lead staff members to worry for the security of their job which would make them more recalcitrant to participate in this project.

Nevertheless, communication and leadership position, even though these notions are highly recurrent in the description of projects or changes implementation and LM application, are not the only elements to be wary of. Multiple paper highlights the necessity to train their staff, win their trust, as well as their motivation for the project, along with all involved parties, at all levels (Puvanasvaran, Megat, Hong, & Razali, 2009).

According to Elnadi et al. (2013) the involvement of staff is necessary, with leadership's support, to implement a solution and they should be responsible for this too. The need for training staff members with leadership as role model and support is also discussed in the article written by Tiso et al. (2021). Cases studies led in one of the analyzed articles, placed training and education as the most critical success factors for Lean Six Sigma application. Showing the importance of employees' development and competences is necessary to ensure the successful implementation of a solution. These factors were even ranked above top management involvement and commitment, as well as communication (Saja & Jiju, 2013).

Salontis and Tsinopoulos (2016) went further, saying that “It is not possible to have commitment from high management and workforce on something that they do not really understand.” (p. 149), stressing even more the importance of communication on the project or change being implemented, but also on the education of the stakeholders on it. To permit this, the Sunda et al. (2014) declared that defining metrics, measurements and a roadmap could develop employees’ awareness. Moreover, it is said that companies prioritizing investment in the training and education of their workforce are more likely to obtain better results in their operations but also in the implementation of the desired changes (De la Vega, et al., 2023).

Employees’ mental disposition is also often cited as an important element for implementing changes. As explained in analyzed academic reviews, with the reassurance of employees concerning their job stability (Maware & Parsley II, 2022) or with the establishment of a strategic framework (Elnadi, Shehab, & Peppard, 2013), it is necessary to give them insight on the change to help them understand its direction and build or maintain trust, as well as confidence with higher management. Employees should have faith and be comfortable to rely on their hierarchy. In this way, they would be more inclined to actively participate in this project, share their ideas and perspective (Perez Garcia & Bolton, 2013). Indeed, for the success of this change implementation and LM application, these stakeholders need to be trained and engaged in this endeavor. By doing so, it will be possible to increase their responsibilities (Puvanasvaran, Megat, Hong, & Razali, 2009), which will lead to creating a feeling of belonging to the company, as well as bring higher job satisfaction to the staff member, which will benefit to the implementation of changes and LM elements (Baides & Moyano-Fuentes, 2012).

It is important to motivate employees and have them committed to their job or the implementation of this project. However, as their motivation or commitment cannot be demanded like their attention or their presence on the premises , it is necessary to correctly use the notions discussed above such as training, engaging, communicating, …The correct application of these elements can facilitate the obtention of their motivation and commitment (Helmod, 2020).

2.3. Literature Review Resume

To summarize, LM is an integrated socio-technical system, as it offers multiple technological practices and principles but also takes into account human aspects in its applications (Paez, et al., 2004). LM has for goal to eliminate waste (Baides & Moyano-Fuentes, 2012) and derives from Lean Manufacturing, a production system (Salonitis & Tsinopoulos, 2016). LM is also defined, more generally, as a managing method using alterations to adapt to the actual market (Dekier, 2012), or specifically, as an approach meant to systematically improve a company's efficiency and quality (Lawal & Elegunde, 2020).

In addition, LM is associated with Lean Thinking as it leads its main guidelines (Elnadi, Shehab, & Peppard, 2013). They both aim at eliminating waste from organizations' processes (Dekier, 2012), as they are considered useless since they add no value to the product or service (Helmod, 2020). This type of waste, also called Muda (Grzelczak & Werner-Lewandowska, 2016) can also be waiting times between value-added activities, scraps or reworks resulting from excess variability or unnecessarily long cycle times (Salah, Rahim, & Carretero, 2010). Paquin (1962), as cited in Ramkumar et al. (2019), identified seven categories to differentiate wastes in businesses (transportation, motion, overproduction, inventory, waiting, defects and over-processing), stating that despite their differences, they influence each other. Kadarova (2016) added an eighth one (talent).

However, a focus on the application of LM in the manufacturing sector has been observed in the analyzed articles and confirmed by Elnadi et al. (2013), regardless of its importance in the service sector, as well.

Another management philosophy related to LM, Kaizen, meaning Continuous Improvement, has for main focus the improvement of businesses, making it essential for LM implementation (Grzelczak & Werner-Lewandowska, 2016).

Lean Six Sigma has a similar goal to Kaizen with a focus on improving quality and reducing time and cost (Alnadi & McLaughlin, 2020). It was created from the combination the Six Sigma methodology, for which a high level of quality with low variability is aimed, and Lean principles (Salah, Rahim, & Carretero, 2010).

As describes above, LM and its associated notions require a systematic revision of the company's processes and the realization of improvement project. To execute these, the stand

and attitude of upper management toward these changes is one of the critical factors determining their successful implementation or their failure (Salonitis & Tsinopoulos, 2016). Leaders need to accompany their teams and support these changes for their accomplishment (De la Vega, et al., 2023).

Their approach should be adapted to the context and their interlocutor to ensure its effectiveness (Alnadi & McLaughlin, 2020). However, this support can be provided through various means, such as communication, by sharing the purpose of these changes (Maware & Parsley II, 2022) and demonstrating their commitment to these endeavors to engage their team members in this project (De la Vega, et al., 2023). The strategic plan and guidelines of these changes should also be shared to ensure its clarity to all stakeholders (Saja & Jiju, 2013).

This plan is a crucial factor for the implementation of changes in companies as its absence can lead to staff members' resistance to change (Maware & Parsley II, 2022). However, their involvement is necessary to the implementation of the project (Elnadi, Shehab, & Peppard, 2013).

These elements should be accompanied by the education and training of stakeholders to guarantee the understanding and commitment of the changes implemented from everyone (Salonitis & Tsinopoulos, 2016). Through this support from the leadership, communication on the changes and their strategic plans, as well as the education and training of staff members for this project, stakeholders can more easily build or maintain trust and confidence with higher management (Elnadi, Shehab, & Peppard, 2013). In addition, they can become more involved and take on more responsibilities (Puvanasvaran, Megat, Hong, & Razali, 2009) leading to higher job satisfaction, which will benefit the implementation of these changes (Baides & Moyano-Fuentes, 2012).

Chapter III - Methodology

3.1. Research Design

This project used quantitative information, such as volumes or time units, in order to identify the main issues of EBTs' evacuation process and the best solution to solve it. During the realization of this project, qualitative information, such as feedbacks from stakeholders or layouts of the FC, was also used to better understand the repercussions of realized changes, as well as the possibilities when modifying the concerned process. Moreover, the realization of this study required a qualitative and exploratory research method to provide a comprehensive understanding of LM challenges in companies such as Amazon France. In addition to detailing the unfolding of this project, this manuscript will also aim at discussing principles of LM applied and notions related to the implementation of changes used for improving this evacuation process.

3.2. Data Collection

This work was realized with the use of primary and secondary data. Primary data includes the list of necessary steps for the evacuation of EBTs from LIL1, the job of the people involved in each of these tasks, the time needed for these steps, the volumes processed through the whole evacuation circuit, as well as the localization of each step across the FC. It also includes data on volumes received at LIL1 from other Amazon sites in 2023, volumes sent from LIL1 to other Amazon centers during that same year and the percentage of articles in totes per week, in 2023. These data were collected through in-person observations, physically following the whole evacuation process, discussions with involved parties and people regularly working on related tasks, as well as extracted from the company's reporting tools. They were then processed to extract the number of Totes received at the FC during this year, the volumes of BTs sent to other centers, as well as the amount left to evacuate from LIL1. The time needed to process these volumes was also deduced based on the information gathered. Primary data also included semi-structured interviews with employees and managers. However due their format and their frequence, they have not been recorded. The tools used for data collection and analysis included Excel for organizing data and Amazon's dashboards for monitoring and analyzing operational metrics, such as volumes of articles received at LIL1, percentage of these articles coming from

BTs, average number of articles per Tote, as well as volumes of articles sent out of LIL1. The extracts of these data, once regrouped and sorted in Excel tables, can be found in the Annex B. 1, below.

Secondary data used for the realization of this work originates from literature reviews. This data was exclusively used for the realization of this manuscript and the observation of the project's unfolding.

3.3. Data Verification

Once the data collected and organized in Excel tables, they were presented to relevant managers in both teams working on the morning and afternoon shifts. These included the two managers from the Docks department, responsible for unloading trucks at the FC, the six managers from the Stow department, responsible for the storage of articles in the FC, the two Inbound Flow managers and their leads, responsible for coordinating all Inbound departments during their respective shift, the two inbound Operation managers, overseeing all activities related to the reception of articles on the FC. The data were also presented to two Shipping managers, responsible for all dispatches out of LIL1, as well as the two Senior Operation managers, respectively responsible for Inbound and Outbound departments over all shifts. These managers confirmed the accuracy of the collected information, they also contributed in providing additional sources from the company's platform to collect more detailed data and ensure no critical points were overlooked. This verification step took place through various informal meeting with these managers where data were presented, discussed and inaccuracies and errors were highlighted to be corrected. This step was crucial to validate the findings and make necessary adjustments based on managerial feedbacks. However, due to the informal format of these meetings, no transcripts of these conversations were done. Elements needing reviewing were directly highlighted on the document and corrected right after the discussions.

3.4. Data Analysis

The collected data, available in the Annex, were analyzed using descriptive statistics to calculate, EBTs volumes, total processing time, average time per EPB, and general cost metrics.

This analysis helped identify inefficiencies and areas for improvement. The data were cross verified with involved parties (triangulation process), as detailed previously, to ensure accuracy and address any discrepancies. This cross verification took place in the form of informal meetings, mostly one on one, where data and results were reviewed with managers listed above. Discussion about the source of the data and their accuracy with the reality experienced by these managers took place. If any anomaly was found or suspected in the data, the steps leading to their obtention were repeated to correct any mistake or to ensure their reliability. This cross verification also often led to the obtention of additional data that were used to adjust the results obtained and improve their accuracy.

3.5. Analytical Techniques

The research methodology began with a comprehensive situation analysis of the processes involved in the treatment and evacuation of EBTs. To create a detailed spaghetti diagram (cf. Annex A), direct observations were conducted, along with interviews of employees working on the process during the information collection phase. As these interviews were informal no record was made of them. The path used to evacuate EBTs from the FC was physically followed to ensure no step was missed and meet the employees working on involved processes in their working environment. Graphs and tables on Excel were realized to obtain a layout of the volumes that could be processed, the hours needed to treat these volumes and the organization of the various areas to fill the needed tasks. These graphs and tables are available in the Annex A, at the end of this document Additionally, leads and managers overseeing or involved in the general process of treating EBTs were engaged to confirm the results obtained and collect additional information or ideas during the brainstorming phase of the project. By physically following the path taken by EBTs through various stages, each step was meticulously documented, detailing the time required, the individual responsible, the volumes treated and the sequence of activities, in an Excel spreadsheet available in the Annex A.

Based on the volumes processed for each area and the time needed to do so, an estimation of the time needed to treat the volumes reported from the previous year was made. This estimation was decomposed by quartiles, months, weeks, days, shifts and hours to obtain a detailed view of the resources allocated to these tasks (cf. Annex B. 1). The same method was applied to determine the savings that will be realized with the implementation of the solution (cf. Annex B. 2).

Chapter IV - Information Presentation and Analysis

4.1. Project’s Information

4.1.1. Data Description

The data collected for this study was critical to understanding the operational processes involved in the treatment and evacuation of EBTs from the FC. This data was crucial for identifying current efficiencies and areas for improvement.

The types of data collected during this project can be broadly categorized into process data and operational data. Process data includes detailed documentation of each step leading to EBTs’ final evacuation from the FC. This documentation regroups the consecutive activities involved in handling, sorting, and transporting the EBTs (cf. Annex A). This data set has for key elements the time required to complete each task, the number of people involved in each step, and the volume of EBTs processed at each stage. These metrics were essential for identifying bottlenecks and assessing labor efficiency within the current system. These data were collected in-person on the FC and during the execution of these steps to ensure they matched the reality of the field. The person working for each of these steps were directly consulted.

Operational data, on the other hand, included volumes of articles received at the FC, with a specific focus on the percentage of these articles arriving in BTs. Additionally, information on the average number of articles per Tote was collected, the number of shifts per day, hours of work per shift, and the volumes of articles sent to other FCs, to determine how many of these Totes were received at LIL1, every hour, shift, day, week, month and trimester, as well as how many of these needed to be sent to other Amazon centers, and by consequence would not need to be counted for the evacuation process. These data were extracted from company’s reporting tools compiling all operational metrics from the previous year, 2023. Financial data, such as the cost incurred for each hour of processing at the FC, was also included to provide a financial perspective on operations (cf. Annex B). This information was obtained by discussing with the Finance manager of LIL1.

4.1.2. Data Preprocessing

In order to prepare for their analysis, data used during the realization of this project, to support the necessity for the solution implemented, went through various steps. These data once collected were cleaned, which addressed missing values, outliers, and inconsistencies to ensure the accuracy of the data set. This included cross-verifying entries, removing duplicates, and addressing any anomalies. Following the recommendations of one of the Inbound Flow managers, data related to 2023's volumes processed at LIL1 were double checked by using two reporting tools of the company. This step permitted to ensure that volumes used were true to reality and no mistake was done, on this aspect, that would falsify the results.

They were then transformed, which involved aggregating and normalizing the data to make it suitable for analysis across different time units such as days, shifts, hours, and trimesters (cf. Annex B). The number of Totes received at LIL1 was deducted by calculating the number of articles originating from BTs, by using the percentage of articles received from Totes and the weekly volumes of articles received at LIL1 in 2023. Once the volumes of articles received by BTs calculated for each week, the number of Totes was deducted by dividing these volumes with the average number of articles in each Totes. The same method was used to calculate EBTs used by the Transfer Out (TSO). All these data are from 2023 activities at LIL1 and were taken from Amazon reporting tools. The number of pallets to be evacuated was also calculated on the basis of each pallet could carry 40 EBTs, as instructed by the company's standards. This ease the realization of estimation as EBTs are mostly processed on this circuit on pallets.

A detailed spaghetti diagram, including a map and a step-by-step table were created to trace the path of EBTs from the Stow department to their evacuation (cf. Annex A), as described above. This diagram provided a visual representation of the entire process flow, highlighting critical points and inefficiencies each color on the map correspond to the tasks realized by different employees and can be linked with information from tables next to each map.

Data used to deduct the volumes received from the FC were then selected from various company tools and transformed into formats that allowed for comprehensive analysis. Weekly data on the number of articles and their percentage arriving in BTs were used to estimate the number of BTs received at the FC, as previously described. This data was converted into various time frames to ensure a thorough analysis. Similar methods were applied to estimate the volumes for the TSO, using weekly volume data and the average number of articles per BTs.

This estimation helped in determining the needs for EBTs evacuation. Based on the spaghetti diagram results, the time required for treating these elements was estimated, and potential time and financial savings from each proposed solution were calculated and converted into percentage gains. According to the findings, one pallet required in average 26 minutes to be processed with the original system. This resulted in a cost of approximatively 3 764€ per week for the FC, on the basis that one hour of labor costs 32€ for LIL1.

4.1.3. Data Analysis Methods

A combination of qualitative and quantitative methods was employed to analyze the data comprehensively, during this project. Descriptive statistics were used to analyze time and cost data, providing insights into current efficiency and potential improvements, as presented earlier. Calculations included total processing time, average time per EPB, and general cost metrics. These statistical methods helped quantify the impact of proposed changes and validate expected gains by comparing time needed and costs of the solutions with the current system.

In addition to statistical analysis, a spaghetti diagram was used to provide a visual representation of the current process flow. This diagram was instrumental in mapping out the process and identifying critical points and inefficiencies, as well as estimate the time required to process a pallet of EBTs. The visual tool allowed for an easy understanding of the flow of EBTs through various stages, highlighting areas where improvements could be made.

The data were aggregated into an Excel table, organized by sections, and displayed in different time units, hours, shifts, days, weeks, months and trimesters to ensure a complete overview of these results. Averages per weeks and sums were generated to facilitate comparisons between the current system and proposed solutions. This aggregation helped in identifying patterns and trends, providing a clear picture of the operational efficiency and areas needing improvement.

4.2. Project's Unfolding Analysis

4.2.1. Managerial Aspect of the Project

In addition to gathering and analyzing quantitative metrics, this project required the application of management techniques to ensure its success. As this solution was to be implemented and used by people and not computer, the realization of this project included managerial and human components.

According to literature reviews found for this manuscript, LM aims at continuously improve processes in companies. As this project's focus is to better the evacuation system of EBTs at LIL1, it can be considered as being the application of LM. The goal of this mission was to identify ways to reduce waste and improve efficiency in this procedure that, while essential to the internal operations of Amazon, does not directly add value from the customer's perspective. Through the application of LM techniques, such as waste elimination and process optimization, this project aimed at revising the handling of these EBTs. Contributing to a better management of the general tasks and workflow at LIL1.

This section will present managerial and human aspects of this project, relying on the theorical framework and notions covered in the literature review, to provide a better understanding of the context and decisions taken, but also to better learn from the realization of this project and see what lessons can be learned in the application of LM and the implementation of changes in a company. This part will evaluate the extent to which LM strategies employed were successful in minimizing non-value-added activities or waste, such as EBTs' unnecessary handling and transport. It will also examine how the overall efficiency of the FC was impacted by these strategies, in terms of human behaviors and teams' reactions to this project.

The role of employees' involvement and leadership in the implementation process will also be analyzed here. One of the main ideas from LM literature is the importance of engaging employees at all levels, especially when leading process improvement initiatives. Employees who would be directly affected by these changes were regularly consulted through this project. Efforts to effectively communicate these new processes were also realized during that time. This part of the thesis will evaluate the effectiveness of these efforts, highlighting the challenges faced in earning the support from stakeholders and how these challenges were addressed.

Furthermore, the following section will compare the findings of this project with existing literature on LM in non-manufacturing environments, as well as some notions addressed in manufacturing environment academic reviews. Lean principles have been mainly analyzed in manufacturing industries and, while not all elements discussed in this context can be applied in logistics and service environments, some findings are relevant to this mission and noteworthy to be discussed there. Moreover, these principles' application in logistics and service environments, such as Amazon's FCs, presents unique challenges and opportunities. By conversing on the successes and shortcomings of this project, lessons on the application and adjustment of LM notions and the implementation of change can be drawn for future applications of these principles in the future.

4.2.2. Analysis of Lean Management Implementation

As stated above, LM is often discussed through its use in the manufacturing industry and, by consequences, its notions are often seen in the context of products' creation. However, some of these notions can be applied to logistic companies and service environments. Multiple principles of LM are applied at Amazon. Since these elements were already integrated in the company's framework, the realization of the project has been eased. Their introduction to stakeholders was not needed anymore, employees knew about them and were used to work with these notions permitting a better focus on the improvement of EBTs' evacuation.

In the following sub-parts, LM elements used at Amazon and relevant to the realization of this project will be discussed to provide a better understanding of the context and environment surrounding this mission. These principles will principally be Muda, Kaizen and Lean Six Sigma.

4.2.2.1.Muda

As stated in the literature review of this manuscript, Muda refers to a company's wastes (Grzelczak & Werner-Lewandowska, 2016), or more specifically, activities that do not add value for the customer (Kadarova & Demecko, 2015). These wastes can be allocated to eight different categories: transportation, motion, overproduction, inventory, waiting, defects, over-processing (Ramkumar, Dr. Satish, & Venugopal, 2019) and talent (Kadarova & Demecko, 2015). Since Amazon's warehouses are not part of the manufacturing sector, overproduction, over-processing and defects wastes, might be less often encountered through the company's operations than other wastes. Some of their aspects may still be applicable to this company but not their integrality or through different angles than for manufacturing companies. Amazon's FCs being logistic environments, it is more susceptible to wastes resulting from waiting, talent, transportation or motion. This organization being well known for its rapidity in deliveries, it is crucial for the company to limit to the maximum wastes related to process time or that can impact the speed of delivery to the clients. However, as stated above, Muda's wastes are dependent on each other (Ramkumar, Dr. Satish, & Venugopal, 2019). And as identified by Helmod, (2020), waste is anything that does not add value but cost or time. The original evacuation organization of EBTs did not create value for the customer, but its complexity was creating time and cost to the FC (3 764€ per week). In consequences, it generated wastes by its inefficiency, which could impact the ability of the center to deliver its clients. Although this whole process does not directly add value to the customers, it is still a necessary process for Amazon, that cannot be completely eliminated, and it can impact value-added activities. It is then important to reduce wastes from this process to the minimum.

The project led permitted to mainly minimize transportation, motion and talents wastes. Transportation was minimized for the processes of circling and stacking of pallets. These processes were realized near the PT, once the solution implemented, instead of A Cell. Traveled distances with Totes stacked insecurely on pallets was reduced, as detailed in the Annex D. 2. Motion was also reduced as pallets transported to the A Cell were circled and stacked up, permitting to double the volumes transported and divided the movements between the PTs and this zone by two. Talent was improved, as well, as the implemented solution required less employees in the A Cell for circling and stacking up pallets, zone that was relatively far from other departments' activities, leading to, also, lower needs of supervision there. The workforce in this zone could then be reduced and attributed to other tasks that would bring more value-added for the consumers than the ones from the evacuation of EBTs.

4.2.2.2.Kaizen and Lean Six Sigma

Lean Six Sigma focuses on improving quality, time and costs in companies (Alnadi & McLaughlin, 2020). To do this, the application of Continuous Improvement, also called Kaizen, is needed for businesses (Saja & Jiju, 2013).

Quality is an important part of Amazon's work ethic. The company aims at providing the best quality service to its customers and to deliver products in the most optimal conditions. While the notions of Lean Six Sigma and Kaizen are less relevant for the project, as they seem mainly customer oriented, according to their description (Salah, Rahim, & Carretero, 2010), their implementation in the company led employees to develop a mindset of continuously looking for ways to better their work. Which, even if their effects were not direct on the evacuation process of EBTs, facilitated the unfolding and implementation of the project. Due to their application, employees and leadership were familiar with continuously improving their work processes and reviewing their ways, looking for useless practices to be removed. They were used to test different organizations to find the most optimal one. For this reason, they were more open to change, when implementing this project, and more involved in it.

4.2.3. Stakeholder Involvement and Motivation

Academic articles analyzed for this work often stress the importance of stakeholders' involvement and motivation. These cannot be demanded but can be obtained through the application of various practices (Helmod, 2020).

The realization of a strategic framework, or a plan, can be counted among these practices and as one that was applied for the enactment of the solution to improve the evacuation process of EBTs. The realization of this plan and its communication is the responsibility of the top management (Maware & Parsley II, 2022). In this case, at Amazon, the manager in charge of this project created this strategic framework and communicated it to the concerned parties, with the help of their hierarchy. This framework presented the various steps needed to find and apply the solution. It took the form of a task on the tool Asana, accessible by concerned parties' managers, where all steps were displayed as subtasks. Updates on the evolution of the project was realized though comments under these tasks. Related documents, such as Excel files with volumes, spaghetti diagrams and details of the solutions pursued, were also regularly updated to ensure that all information was available for all concerned parties. Its communication gave visibility to the stakeholders on the status of the project and its purpose.

The realization of this plan could be considered as one of the challenges encountered during this project. As the manager responsible for it had to familiarize themselves with this mission, the tasks to be done were not immediately identified. Some time was needed for them to grasp the full extent of this project and get accustomed to the whole process organization. Once familiar with the situation, the plan could be realized more accurately. However, it was not fixed and had to be readjusted through its implementation to adapt to operations, priorities of the FC and to ensure the solution would fit well the goal of this mission.

Helmod (2020) advises in his book that the realization of a workflow analysis and value stream mapping of the operations. As this process did not add value for the customer, time was used to identify the costs of the different activities (cf. Annex A). The spaghetti diagram, with a list of the evacuation's steps, along with the person responsible for each step, the time needed and the volume that could be processed, gave visibility over this evacuation system. It revealed to be of great help when discussing the mission with stakeholders as it offered a quick view of the whole organization and bottlenecks. This tool was also very useful also for another practice recommended by multiple scholars, communicating about these changes.

Communication is one of the critical elements needed to develop stakeholders' motivation and their involvement. This must be done by top management while raising stakeholders' interest (Puvanasvaran, Megat, Hong, & Razali, 2009). In the situation of the project, communications were mostly performed by the manager responsible for this mission, with support from their superiors and colleagues. As suggested by academic articles seen for this study, communication has for goal to bring clarity as well as reassurance to employees and other stakeholders, concerning to project's purpose (Muszynska, 2015) or the future of their own activities (Salonitis & Tsinopoulos, 2016). During this mission at Amazon, stakeholders have been solicited multiple times to gather their opinions and ideas from the very beginning of the mission. These solicitations were often done in a casual manner, on the floor during operations. For this reason, they usually were quick and lasted a few minutes. This permitted to share information on the new system, such as its purpose, its main points and its requirements. Stakeholders were also more comfortable to directly come to the manager in charge of the mission to share their perspective, as well as inquire about the project and some of its elements or impacts.

As these conversations were often done in small groups or were one-to-one meetings. It might have created an environment where employees could more comfortably come and ask questions or suggest ideas. However, it is also possible that more time had to be spent for this during the realization of this project, due to this informal behavior. Organizing more formal meetings in bigger group could have allowed to share all information at once and faster while answering some questions. This could have also permitted to ensure the same degree of knowledge on the new organization of concerned activities for all stakeholders. However, it would have created a more formal environment around this project, which could have dissuaded a few people to share their ideas or opinions, as they actually did. Ideas that were quite helpful. As the mission was successful and these conversations were numerous, short, casual and not particularly recorded, simply the main points were remembered, it is now difficult to say with certainty if this communication method was the most optimal or if the addition of more formal meetings, in bigger groups, would have led to better results and a more efficient implementation of the project. If these were to be done again, the application of another approach could potentially bring positive results and would be interesting to observe in order to draw more accurate conclusions on this point.

It could have been particularly benefic to perform these more formal meetings with front-line employees. As they are the ones executing the tasks to evacuate EBTs, such as the circling, for instance. They are the most knowledgeable in these and know well what is needed to perform these activities (Baides & Moyano-Fuentes, 2012). These people were, of course, solicited and their outlook on the modifications done, as well as the one needed, were carefully taken into consideration when putting the solution in place.

Some other challenges that were encountered when communicating with stakeholders on this project was the identification of their own benefits in this new organization. As numerous scholars suggested, highlighting the benefits when implementing changes is crucial to ensure stakeholders involvement (Marinescu & Toma, 2008). For instance, while the interest for the whole FC of this mission was clear, managers and employees from the Stow departments asked what the benefits for them would be. These benefits were less obvious and, on the contrary, they more easily saw, at first, the constraints and difficulties that could arise from the changes, for them and their department. As the manager in charge of this project did not have all the elements or authority to answer every inquiry, their superiors was solicited, and more information was gathered to provide them with proper answers, as well as all the elements needed to demonstrate the interest of this project for not only the whole FC but also for their own department.

Lastly, involvement and motivation of stakeholder can also be obtained through their training and education on LM principles, other departments tasks or new activities that will result from the changes in a company. As explained by Puvanasvaran et al. (2009), Continuous Improvement in a company benefits from multi-skilled workers. At Amazon, front line employees are required to be trained and able to perform activities from various departments. This system permits them to alternate between processes and better distribute the workforce depending on the company’s needs at the moment, leading to a higher possibility of job rotations (Baides & Moyano-Fuentes, 2012). This element eased the implementation of the project to improve the evacuation of EBTs as it was not necessary to train additional employees for the activities concerned by the changes. The number of workers with corresponding qualifications was enough for the current needs. This element was benefic to the implementation of the project as it permitted to save time and focus more on other tasks.

It was also of great help when researching the best solution possible for the mission as multiple employees were informed and familiar with the activities involved there. For this reason, they could share a more knowledgeable opinions on the changes that should or could be implemented, their requirements and bring a critical perspective on it. As confirmed by Salonitis and Tsinopoulos (2016), the knowledge and training these front-line employees had on various processes enabled them to better understand these activities, which facilitated the communication on the project with team members, as well as their involvement and commitment to its implementation. This also allowed for questions and inquiries raised to be more specified and technical as employees were already aware and knowledgeable on the concerned activities.

Besides, thanks to employees’ involvement, when in need of workforce on the new activities, several staff members, that were trained but were needed elsewhere, would eagerly help and recommend some of their colleagues, competent in these tasks as well, to perform them and ensure the smooth application of the mission. This greatly eased the implementation of the solution as finding people with the right training, while maintaining the usual activities of the involved departments can be a challenge. This was particularly the case when teams were facing difficult shifts with a high amount of work to do and stressed employees. Front line workers were then of great help to swiftly find replacements for these newly implemented activities while ensuring the necessary workforce was allocated on critical tasks. This element also contributed to the creation of a good work environment where employees were actively involved in decisions, leading to a better teamwork.

4.2.4. Challenges and Leadership Dynamics

Academic articles, emphasis the importance of leadership support when implementing modifications to the environment and needs of the company (Alnadi & McLaughlin, 2020). As brought up at multiple occasions, above, leadership support was important for the realization of this project. Due to the low experience of the manager in charge of this mission, upper management's help was necessary to direct them in the right direction and ensure no steps were missed, as well as provide them with the legitimacy needed to implement the changes.

Due to the recent arrival, in the company, of the manager responsible for implementing the solution, and their little experience compared to their colleagues, their legitimacy in making changes in the operations of the FC and its departments happened to be one of the struggles encountered. To overcome this challenge, discussions with managers from concerned departments and with the upper managers overseeing this mission permitted the person responsible for it to gain the legitimacy and support to put the required changes in action. Among academic articles found, questions on the manager's legitimacy when implementing changes or on struggles encountered due to their recent arrival in the company were not raised. Based on this project experience, it was observed that the support from other managers and upper management, a friendly environment as well as claims supported by strong data were keys to overcome this struggle. Further research on this aspect of change implementation could be interesting as this problematic might concern multiple managers debuting in companies and needing to implement modifications to their environment.

The goal, there, was to not impose these new ways to stakeholders but convince them of their benefits and have them adopt this project willingly. The elements discussed in the previous sections helped attaining this goal but were not always enough to compensate the skepticism from employees that naturally resulted from the freshness of the manager in charge of the project. As said above, the trust from management team, the friendly environment created, and data presented permitted to correct this situation and earn the trust of other stakeholders. The involvement and implication of top management in Lean implementation or the application of changes in the company is often discussed in papers found. Different elements permitting to gain employees' trust and motivation are often presented, as well. However, the impact of top management attitude toward the person in charge of the project and its effect on stakeholders were not part of the main elements discussed in the sources found for this study. However, Salonitis and Tsinopoulos (2016) confirmed that the attitude and behavior of management can be either a barrier or a driver for Lean implementation. This point was proved during the realization of this project and through the situation just presented.

As discussed through the communication aspects of Lean implementation, it is important for stakeholders to have a clear understanding of the project's purpose, as well as be convinced of its advantages. Peansupap and Walker (2006) mentioned that unclear benefits from the application of an activity can result in time loss by focusing resources on unnecessary activities. For this reason, it was important for managers from impacted departments to understand the benefits from executing new activities or modifying their teams' routines. Moreover, as additional processes needed to be added for some services, such as for the Stow, the departments' managers feared that these additions to their daily tasks would lead them to justify supplementary hours for their division, at the end of their shift, leading to increased workload and potentially more challenges for them and their employees, on a daily basis, to meet the FC and company's requirements. While the advantages for the FC were clear and answers to these questions from departments' managers were brought after discussing these points together, anticipating these inquiries and doubts could have been done better, saving a little time, as most answers would have been answered immediately and did not require confirmation from higher ups. However, when implementing changes, some doubts and inquiries might need superiors' approval and confirmation. For instance, in this project, the question of hours' justifications and the impact of new activities in Stow department's routine could not be answered directly by the manager in charge of the project as they did not have the authority to do so. The question was then brought to higher management who could decide who would be responsible of these activities' justifications. The support and commitment of top management was then proven to be necessary for the implementation of the solutions as well as to obtain other managers' commitment, as discussed through multiple academic literatures analyzed (Puvanasvaran, Megat, Hong, & Razali, 2009).

4.2.5. Practical Implications and Recommendations

While a solution leading to a saving of 33% of the EBTs evacuation system was implemented, additional improvement could still be done to minimize wastes associated to this process, and further apply LM principles. However, due to the time constraint of this project, these additional elements were suggested at the end of the mission for the concerned teams to apply later.

As explained in the previously, an additional improvement was suggested, at the end of the project, that could lead to 47% of process costs saved for the EBTs coming from the East PT, instead of 33% saved. However, with more time allocated to the realization of this mission, other solutions could have been found an implemented to minimize even more resources assigned to the evacuation of EBTs from LIL1.

For instance, including the needs of BTs from Outbound's activities and systematizing their supply from Inbound's departments, especially from the Stow, could lead to a more optimized and leaner system with less wastes resulting from it. Indeed, as explained above, these services, while using BTs in a close circuit, happened to need their stocks to be refurbished from time to time. They had different ways to do so but it was not standardized or optimized. Due to the time constraint of this mission, these needs, while identified, could not be addressed and included in the applied solution. However, as LM principles suggest, processes that do not add value to the client should be eliminated or minimized. Following this, it was then recommended for LIL1 to continue this project and further improve the FC's organization, as well as minimize even more these activities generating waste.

On the same theme, Kadarova and Demecko (2016) said that application of LM can lead for the company to require less space. The resource of space has not been found often in the articles viewed for this work. However, experiences and observations from this project led to the conclusion that it could also be considered as waste if not used for value added activities. Once ready EBTs could not be evacuated immediately as the ordering of a trucks from outside of the FC was required. The arrival of these trucks could take a day or more, depending on external factors. During this time, EBTs had to be stored at the FC. If no truck could come for a few days, the FC would stockpile them, taking on space that would be needed for activities adding value to the consumer, such as unloading shipments with articles in them. Despite the anticipation of trucks orders by LIL1's teams, these situations were dependent on factors external to the FC. However, due to the potential impact of storing these EBTs in the center, it would be recommended to work on a solution to limit the space taken by these, especially in the absence of trucks to evacuate them, to better allocate the space on the site and use it for value added activities instead of dormant items.

Based on this project's experience and findings some notions could be interesting to remember and apply to future LM projects, in other sectors. Despite the fact that their needs differ, and LM implementation requires to be adapted, some learnings from this experience are interesting to keep and apply. For instance, if the system that needs improvement includes the transportation of items or resources from one place to another, one of the first elements to study there could be the need for this transportation and if this process is optimized or not, if the volumes transported cannot be increased for each trip, if the distances cannot be reduced, … While all situations are unique and have various requirement, optimizing transportation and movement in an organization, in particular a non-manufacturing one, can lead to significant savings for potentially little to no investment, as it happened for LIL1.

Another benefic point that was observed during this project, that can be applied to any sector and was confirmed by analyzed academic articles, was the collaboration with stakeholders. While some interactions during the implementation of this project could have been done differently and potentially better, as discussed above in this manuscript, a close collaboration, clear and transparent communication as well as good relations with teams' members, in addition to clear guideline and defined purpose, greatly benefitted to execution of this mission. All the analyzed articles encourage these elements in the application of LM principles and this project confirmed them again. It is important, for further missions and projects, to apply these notions to ensure the smooth implementation of changes but also find the best suited solution for the organization.

In addition, this project demonstrated the importance of leadership and top management commitment to the project, as well as their support toward the manager in charge of it, to ensure the commitment and trust from other stakeholders. This notion was also often discussed in analyzed academic reviews and confirmed through this mission. During this project, the unity of leadership teams gave legitimacy to the manager in charge of this mission, to implement these changes and helped front line employees to better trust the new process as well as be more open to it. This element can be applied independently of the company's sector. It is also critical to the project as no change can be implemented if no-one believes in it and put it into action.

Chapter V - Implementation and Results

5.1. Solution Brainstorming

5.1.1. Description of Proposed Solution

To improve the evacuation system of EBTs, multiple options were suggested and analyzed through various conversations with AAs involved in this process, as well as with concerned leads, area managers, operation managers and senior operation managers.

One initial idea was to simply move the zone where pallets of EBTs are circled and stacked up, in the A Cell. Their new locations would be the stages where they are stored instead of the area where they are currently circled (cf. Annex D, Table D. 1). However, this idea was quickly put aside as it would be too little of a change to improve the current process, and other options seemed to be a better fit for LIL1's needs and problematics (cf. Annex B, Table B. 2).

Another solution was to evacuate EBTs directly from the dock doors in D and F Cells (respectively located in the West PT and the East PT), instead of moving them to a further location in the FC, such as the A Cell. After discussing this idea with leads and managers of the concerned departments, it was discarded as it would need extra maintenance costs due to some particularity of these dock doors. These doors were not used and were not equipped with ramps permitting to load or unload trucks. Equipping these doors would be costly, take too long, and other options would be more easily implemented and affordable. This idea has not been written and studied further as it was quickly put aside after being raised while discussing with Inbound Docks managers and one of the Inbound operations managers due to the complexity and costs that would be generated from simply equipping these doors, and the uncertainty that this solution would really be a fit for the FC in practice.

However, one point of this solution was retained. In order to evacuate EBTs from these doors, it would be necessary to circle and stack them up directly in the PTs they come from instead of the A cell. This modification for the evacuation process seemed promising as it would double the number of pallets transported at once to the A Cell and could lead to further possibilities afterwards. The only blocking factor would be the creation of these circling zones, a topic that will be covered below in this study.

Some other options involving the Outbound needs were also suggested and analyzed. However, due to constraints such as limited time and the complexity of reorganizing both Outbound and Inbound processes, these options were not pursued further. The Outbound also uses BTs to transport articles to their various departments. Their BTs' circuit is usually a closed one, not needing additional Totes. However, for multiple reasons, EBTs need to be sent from the Inbound to replenish their stock, from time to time. These Totes are then not evacuated from the FC but reused by the Outbound's departments. Due to time constraints, and the primary focus of this project being the Inbound needs, these ideas were not analyzed further and stayed at the stage of suggestions. With more time, spaghetti diagrams and tables could be realized as it was done for the Inbound's departments, but this would require more time than what was given during this project. It remains, however, suggestions on which amazon's teams can work later on.

One idea was to have AAs place EBTs in the Pick's (department responsible for gathering the articles, ordered by clients, in the warehouse) piles used by the employees from the Outbound department. These piles were located all through PTs where both Stow and Pick departments had their operations. However, it presented multiple flaws such as potential errors in the system, increased workload, and safety concerns for the employes. Another idea proposed was to automatize the restocking of BTs for the Outbound services through a threshold system, and evacuate EBTs as usual, once this threshold reached. Unfortunately, this suggestion faced various challenges like reduced buffering capacity for the concerned departments and increased monitoring workload. These issues, along with the time constraints, led to the decision to not pursue these proposals during this project. However, with more time, it would be possible to improve them and put in place a solution for Outbound departments too.

5.1.2. Evaluation Criteria

Each proposed solution was evaluated based on several criteria:

- Feasibility: The possibility to implement the solution following defined limitations. For instance, if implementing the solution requires extensive changes for the center, its departments, or the degree of operations' reorganization needed.

- Impact on efficiency: The potential for the solution to improve the efficiency of the EBTs evacuation process, the amount of process hours saved with the solution, the number of staff members needed for the whole process and the financial savings that will result from this change.
- Cost: The financial investment required to implement the solution.
- Implementation time: The time needed to put the solution into practice.
- Compatibility with existing systems: How well the solution would fit current operations and systems, in terms of tasks' organization but also physical organization.

5.1.3. Stakeholder Feedbacks

Feedbacks from key stakeholders, including AAs, leads, area managers, operation managers and senior operation managers, were crucial in refining and evaluating the proposed solutions. Discussions with the Inbound Docks' team highlighted logistical challenges regarding the possibility to evacuate EBTs from other locations than the A Cell, while insights from the Outbound and other Inbound teams revealed potential operational complications and risks, such as workforce availability, training possibilities and requirements, possible layout modifications, machines availability, ...

5.1.4. Solutions Comparative Analysis

A comparative analysis of the proposed solutions was conducted, highlighting the pros and cons of each. The table below summarizes the findings:

Idea	Feasibility	Impact on Efficiency	Cost	Implementation Time	Decision
Circling and stacking different zone in A Cell	High	Low	Low	Short	Not Pursued
Evacuation from East and West PTs' doors	Low	High	High	Long	Not Pursued
Stacking BTs in PTs	Medium	High	Medium	Medium	Pursued Further
Adapting to Outbound needs	Low	Medium	High	Long	Not Pursued
Associates leaving EBTs in Pick's piles	Low	Low	Low	Medium	Not Pursued
Threshold on Outbound EBTs' buffers	Medium	Medium	Low	Medium	Not Pursued

Figure 5.1: Comparison of proposed solutions

5.1.5. Selected solution

After thorough evaluation and feedbacks from stakeholders, it was decided to implement a circling and stacking zone in each PTs, instead of performing this task in the A Cell. This approach's aim was to double the volumes transported to the A Cell, reduce movements between the PTs and this zone, as well as lower the time needed for the entire process.

5.1.6. Key Concerns and Resolutions

The implementation of the selected solution raised several concerns among stakeholders. These concerns also led to some revision of the solution and to the creation of additional ideas for its implementation improving the involvement of employees in the project, as Baides and Moyano-

Fuentes (2012) explained in their academic literature. Each concern was carefully addressed to ensure the smooth integration of the new process into the existing workflow.

1. Location of zones:
   - Concern: The primary concern was to determine the appropriate location for the circling and stacking zones, especially in the East PT.
   - Resolution: After thorough discussions with the Safety team and observing the area's layout and movements, it was decided to establish the zone in the existing area used for evacuating EPBs (cf. Annex C). This decision required remodeling the zone's current organization, including building a safe space for the circling and staking up, with high barriers, as well as places for the machines to be used, and relocating waste containers used by a partner company. The new location for these containers was coordinated with the company and the Stow area managers, which also resulted in a more favorable working environment for the partner's team. For the West PT, it was decided to use an already existing zone and reorganize the operations to use this area (located in the zone named Receive West on the layouts in Annex A), including the revision of AAs' movements and tasks attributions.
2. Responsibility for oversight:
   - Concern: There was uncertainty about which department would oversee the new circling and stacking processes.
   - Resolution: Given that the new processes will take place in the Stow department's operation area, it was decided that this department would be managing the circling and stacking of the EPBs. This decision ensured that the process remains under a single department's management, ensuring smoother oversight and accountability on the long term.
3. Work hours and justifications' attribution:
   - Concern: Stakeholders were concerned about the tasks attribution of AAs performing this job and whether this new process would add additional hours needing to be justified, in particular by the Stow department.
   - Resolution: It was confirmed with one of the Inbound Operation Manager that AAs assigned to this new process will be associated to the same work bucket as the one formerly used in the A Cell for this task, and the hours will not be imputed to the Stow department. This approach ensured that the additional

workload would not impact the department's performance metrics or create administrative burdens for its managerial team.

4. Evacuation capacity:
    - Concern: There were concerns that the new zone might reduce the capacity for evacuating pallets and EPBs from the PTs, especially the East one.
    - Resolution**:** Consultations with AAs and Stow area managers led to the design of a new layout that maintained, and even improved, the evacuation capacity (cf. Annex C, Figure C. 2). The new area, with stacked EPBs taking up fewer slots due to their double-stacking configuration, will have a higher storing capacity than the previous one. Which ensured that the evacuation capacity is preserved and possibly enhanced.
5. Integration into daily activities:
    - Concern: Integrating the circling and stacking of EPBs' pallets into the Stow department's daily activities was a major concern.
    - Resolution: For the East PT, a continuous stream process was proposed where AAs will handle the circling and stacking as the EPBs come back from the Stow. For the West PT, a wave process was suggested due to its organization being different from the East PT. EPBs will be buffered on carts and processed in groups to ensure efficient workflow integration. These processes will be refined through multiple trials to optimize the organization and find the one that would be the most suited to these teams' workflow.
6. Benefits for the concerned department, especially the Stow:
    - Concern: Impacted departments were concerned about the workload that would come with this process' reorganization, and the benefits that their teams would gain from changing their way of working. In particular the Stow department who initially perceived the new process as an additional workload without direct benefits.
    - Resolution: The benefits for each department were discussed, as well as the issues resulting from the current organization, in order to appease their apprehensions. For the Stow services, it was clarified, with the approval of the Inbound operation manager, that the hours allocated to this process will not need to be imputed to them. The improved evacuation capacity for pallets and EPBs, along with the autonomy and flexibility in managing their evacuation flows, were highlighted as key benefits. By managing the circling and stacking

themselves, the Stow department would gain independence from other departments' schedules, enhancing their operational efficiency and flexibility.

5.2. Results

With the solutions approved, the next step involved implementing the selected ones. This section details the steps taken, the results of pilot tests, and the overall impact of the implemented solutions. This process began with the necessary preparations, such as securing quotes for materials and obtaining budget approvals.

5.2.1. Implementation in the East PT

Once concerns were addressed and approval was obtained, detailed layouts of the zone in the East PT were submitted to the Safety team (cf. Annex C, Figure 2). Multiple exchanges and tours on the concerned zone with this team were done to ensure compliance with Amazon's safety standards. A project approval document summarizing the context, purpose, supporting data, and plans for the new area, was realized on one of the company's tools to collect official approvals from all involved parties, as well as officialize the launch of the project.

Assets required for the modifications were listed and checked for availability with the person in charge of the FC's layout and modifications. During a meeting with higher managers and members of support departments, such as Safety, Change, Engineering, School and Human Resources, advices were sought for obtaining the items necessary for the creation of the zone in the East PT, in particular double stack barriers. It was then advised to contact another FC who recently got rid of theirs.

After contacting multiple people from the FC, information on the whereabouts of these barriers were obtained. However, the transport of these elements needed to be ordered by LIL1 and as no exchange have been realized between the place where the barriers were and LIL1, no one knew how to create this route. Thanks to other managers, the contacts of people working in the company's transportation department was obtained, leading to the obtention of a solution to convey these elements at LIL1. As this was realized through the company's network, no investments were required from the site.

Due to the company's safety standards, a safety belt was necessary for the creation of this zone. This element was ordered through the Procurement department of LIL1 and costed approximatively 200€. It was the only cost of this whole project.

5.2.2. Implementation in the West PT

Meanwhile, as the Stow department resumed operations in the West PT, after a period where they were mainly in the East PT, the new process was tested using an already available zone from a department in the Receive West area. As this department was not working all year long, the zone was available for use. Allowing immediate implementation of the new process, there, without additional costs. During this department's activity period, EBTs from the West PT will all be used by this department, removing the need to evacuate them and to use this zone for this purpose. Machines were obtained from other parts of the FC, and a list of trained AAs was provided by the School (department responsible for training all employees at LIL1).

Adjustments to integrate this new task into the Stow services' routine were still ongoing by the end of this project. The organization of responsibilities between leads and area managers needed further refinement. Communication and follow-up with other shifts were managed by coordinating with respective area managers, as well with the Flow managers, responsible for coordinating all tasks among Inbound services during the shifts.

Although this system was on hold, when the end of this project was reached, due to the area being under maintenance, it is expected to resume once construction was completed. However, due to time constraints, there will be no more entry on its evolution in this study as the project's follow up was the responsibility of another manager.

5.2.3. Decision-Making and Solution Approval

The decision-making process involved evaluating each solution against the criteria mentioned above, discussing stakeholder feedbacks, and assessing the comparative analysis results.

Solutions were prioritized based on their feasibility, impact on efficiency, and compatibility with existing systems.

The selected solutions were presented to the relevant departments, as listed earlier, for approval. This phase involved addressing several challenges:

- Concerns of managers and employees: These included additional work hours, potential loss of evacuation capacity due to new zones, and organizational aspects of task assignments. These concerns were addressed by researching relevant regulations and providing clear information, based on data and confirmed by superiors to ease worries.
- Safety Department Approval: Obtaining approval for the East PT circling zone's plans from the safety department was challenging. A compromise was needed to balance the requirements of the mission with necessary safety standards. Through continuous negotiation and discussions, a plan was developed that satisfied both operational needs and safety standards (cf. Annex C, Figure C. 2).

Points of concern raised by the departments were noted for reminder, and additional information was gathered to address these concerns right after each discussion. The proposed solutions were refined based on feedbacks and adapted to meet departmental standards. Final approval for implementation was obtained orally after addressing all concerns.

5.2.4. Impact of Implemented Solutions

The primary impacts of the implemented solutions were the confusion of the teams who had to change their ways to adapt to this new practice. The person in charge of this project was regularly solicited to bring more information on what to do, when, how, with whom, with what. The first observations from the organization in the West PT led to the conclusion that the adoption of this new process and its complete integration in the teams' daily routines will require time, support and possibly struggles for it to become natural and be a complete part of the departments' organization. However, the first observations were encouraging regarding the possibility of these new tasks being effectively implemented in the teams' daily activities.

On the long term, and once fully implemented, this solution will bring multiple benefits for the operations, such as a simpler and more optimized evacuation process of the EBTs, with less involved steps and employees. These employees will be able to focus their time and energy on more important tasks for LIL1. EBTs will leave the FC faster and, by consequence, occupy space there for a shorter period of time, space that can be used for other purposes. By needing less work hours on this process, the FC will have the possibility to reallocate the workforce, previously assigned to these operations, on other processes or tasks which are financially more interesting to the FC. Moreover, as the Stow teams will need to rely less on other departments' schedule for the evacuation of its EBTs, it will gain in flexibility and independency with the management of its flows.

Chapter VI - Conclusion

Due to the size of the company, a high number of articles are received each week at the Amazon's FC, LIL1. More than half of these articles arrive from other FCs in BTs. However, once these articles stored in the warehouse, these Totes becomes useless for the site and need to be evacuated. Due to the inefficiency of the current evacuation system and the losses generated by this process, it was necessary for LIL1 to review and improve it. The goal of this project was to improve the evacuation process of EBTs from LIL1.

After carefully observing the current system, gathering and analyzing data from the previous year and discussing with multiple stakeholders, a solution was found and implemented. Based on 2023's volumes, the application of this solution will lead to an average of 1 249€ per week for LIL1. This represents a saving of 33% compared to the original system. Thanks to the company's network and resources, the application of this solution required almost no investment as the majority of the materials required could be found in Amazon's network and most of the savings realized came from reorganizing the tasks related to this process on the FC. However, this system can still be further improved but the time constraint of this project did not permit it. For this reason, suggestions were left to the teams to improve more the evacuation process of EBTs from LIL1, as well as integrate Outbound's needs to ensure that tasks related to EBTs' handling would generate as little losses as possible for the FC. The creation of a circling and stacking zone for EBTs pallets, in the East PT, and the organization of similar tasks in the West PT, opened the path to additional improvements for the site.

The realization of this project also led to valuable observations on LM practices and change implementation notions. The LM implementation at an Amazon's FC has shown that the application of its principles, traditionally rooted in manufacturing, can successfully improve efficiency and reduce waste in a service or logistic context. As shown through this project, activities that do not directly value to the customer can be important for the company's internal operations and cannot be completely removed. Through this mission, the evacuation of EBTs has been improved by minimizing motion, transportation and talent' wastes, leading to a leaner system with reduced operational costs and better efficiency. Unnecessary movements were decreased, and the FC's workforce could be organized in a better way, permitting to more efficiently use their skills and talents. For instance, the reorganization of EBTs' pallets circling and stacking reduced the frequency and distance of transport, while also permitting to dispatch employees to tasks directly contributing to value-added activities, leading to a more efficient use of the workforce.

Effective communication, as well as the involvement of leadership played an important role in the project's success. The support of the managerial team contributed to legitimizing the mission and gaining trust from all stakeholders. The implementation of changes, following the realization of this project was also eased with the help of the managerial team. Through this project, the important role of leadership was demonstrated when applying LM notions and introducing changes in a company, confirming recommendations found in multiple academic literatures viewed. This role included guiding the process of change, defining and transmitting clear objectives, and ensuring that all concerned departments were aligned.

The importance of employees' involvement in the change process was also clearly visible through this mission. This positively contributed to address concerns that may arise, to gather valuable feedbacks leading to a more fitted solution for the FC, as well as building a sense of ownership and belonging among those affected by the changes. This approach not only eased the acceptance of new procedures but also enhanced the overall effectiveness of the implementation.

Despite the successful implementation of a solution, several challenges were faced during this project, in particular regarding the obtainment of all stakeholders' involvement and motivation in this mission. Initially, some departments' teams struggled to see the benefits of the changes for their individual activities. This led to some resistance to implement and apply these modifications. This situation demonstrated one of the main challenges of LM as often discussed in academic literature, which is the need for clear and targeted communication. This communication needs to highlight the benefits of process changes to all stakeholders. Moreover, it is important for each department to understands the positive impact on their operations that these implementations can bring, as it is an essential element to overcome resistance and ensure all involved parties accept and adopt the new system. Thanks to data gathered during the initial phases of this project, the support of managerial and hierarchy members at Amazon as well as the friendly environment of the company these challenges were overcome. Through this experience, the importance of demonstrating unity and trust among leadership also appeared to be essential for the success of the project. This was particularly crucial as the manager in charge of this mission was new to the company and did not earn yet the full trust of all stakeholders. The support of the managerial team participated in the creation of a favorable environment for the implementation of the solution where employees were more confident in the benefits of reorganizing the evacuation system of EBTs and were also more confident in its successful implementation.

This work contributes to the general understanding of LM application in companies and, more specifically, brings insights as well as a better understanding of its use in services or logistics environments. As most studies and academic reviews observed for the realization of this study focus on the manufacturing sector, this project offers a new insight for future research, by demonstrating that LM principles can be effectively applied to improve processes, that are essential to internal operations of a company, in the logistic sector, even if these processes do not generate direct customer value. By consequence, this work, by focusing on optimizing non-value-added activities that are necessary, provides a new perspective on how organizations can achieve operational efficiency in various settings.

Looking forward, further research is needed to explore the application and long-term impacts of LM application in non-manufacturing sectors, in particular regarding operational performances and employees' engagement. It is also believed that additional studies on the relations between the position of a manager, their novelty in the organization or in this position, the changes they intend to implement and the acceptation of stakeholders toward these changes would prove to be of use to the academic and operational world. As information on this perspective when modifying processes in a company has not been found in the resources viewed for this study. Moreover, further research into waste categorization, in particular concerning the optimization of space in a company, can prove to be useful for companies and academic literatures. Experiences from this mission showed the importance of improving the use of space and how it could impact the majority of operations in a company if its use was not optimized.

In conclusion, the reorganization of the EBTs evacuation process at LIL1, an Amazon's FC, demonstrated the effectiveness of LM in reducing wastes associated to non-value-added activities and in improving the efficiency of a system in a non-manufacturing context. A solution was found and implemented within the time allocated to this project and suggestions were left for additional improvements. Through this study, the importance of leadership behavior and position, stakeholder involvement and motivation, as well as a clear and transparent communication to successfully implement LM strategies and improve operations in a company were highlighted, as they were critical elements in the success of this project. LM, when adapted to the specific needs and contexts of different industries, remains a powerful tool to ensure efficiency, innovation and Continuous Improvement in organizations, as they continuously search for ways to optimize their operations and stay competitive.

6.1. Limitations of this project

The primary limitation of this project was the time constraint, as the entire project needed to be completed within six months. This limited the scope of some activities and required prioritization of certain tasks. Additionally, addressing the concerns of managers and employees and obtaining safety department approval added complexity to the project.

Another limitation involved the material found to write the thesis. Most articles found on LM analyzed this concept through the manufacturing sector's perspective. Even though multiple elements could also be relevant for an application in logistic operations or service sectors, some notions had to be set aside as their application was not possible in an environment other than manufacturing.

Chapter VII - References

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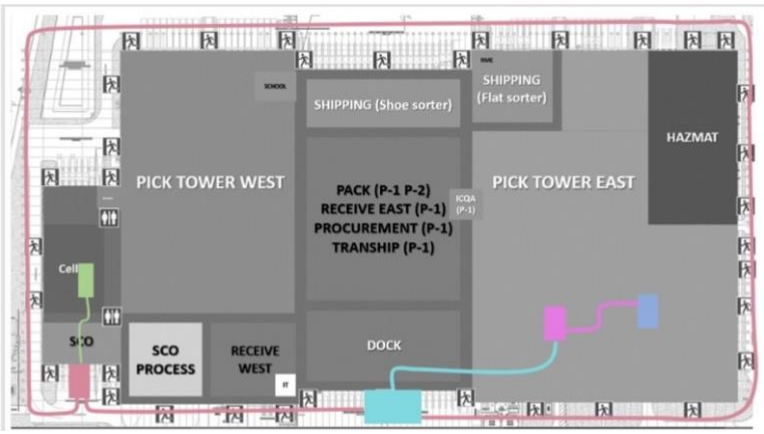
Chapter VIII – Annexes

Annex A – Spaghetti diagrams

Figure A. 1: Spaghetti diagrams of EBTs' evacuation process from West PT to Cell A

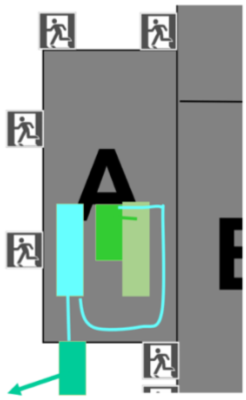
Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Associates	Loading U-boats with EBTs	Depending number of Aas and Totes to be stowed		1	0
2	IDRTs	Transfert EBTs on pallets	2,5 - 3 min	3	1	3
3	Pit dock	Transfert pallets to Cell A	5 min	5	2	2.5
4	Pit dock	Way back from Cell A	5 min	5	2	2.5
			Total	13		8

Figure A. 2: Spaghetti diagrams of EBTs' evacuation process from East PT to Cell A



Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Associates	Loading U-boats with EBTs	Depending number of Aas and Totes to be stowed		1	0.00
2	IDRTs	Transfert EBTs on pallets	2,5 - 3 min	3	1	3.00
3	Kamag	Empty trailer's transit	Around 30 min	30	33	0.91
4	Outdoor Marshall	Trailer's docking at the Inbdound Docks	Around 10 min	10	33	0.30
5	Indoor Marshall	Docks door's opening	Around 3 min	3	33	0.09
6	Pit dock	Pallets' tranfert to the trailer	Around 30 min	30	33	0.91
7	Indoor Marshall	Docks door's closing	Around 5 min	5	33	0.15
8	Kamag	Transit of loaded trailer to Cell A	Around 30 min	30	33	0.91
9	Outdoor Marshall 2	Trailer's docking in Cell A	Around 10 min	10	33	0.30
10	Indoor Marshall 2	Cell A door's opening	Around 5 min	5	33	0.15
11	Pit docks / Cell A	Pallets' unloading + non-prep pallets's stored in stages	Around 30 min for 1 AA	30	33	0.91
			Total	156		7.64

Figure A. 3: Spaghetti diagrams of EBTs' evacuation process from Cell A to LIL1's exit



Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	AA responsible of circling	Pallets transfert from stages to circling zone	2-3 min	3	1	3.00
2	AA responsible of circling	Pallets' circling	Around 1 min	1	1	1.00
3	AA responsible of circling	Stacking up of circled pallets	2-3 min	3	2	1.50
4	AA responsible of circling	Circling of stacked up pallets	Around 1 min	1	2	0.50
5	Pit dock / Cell A	Processed pallets' transfert to storing stages	Around 3 min	3	4	0.75
6	Pit dock / Cell A	Storing of processed pallets in Cell A, awaiting for the evacuation's truck arrivals	Around 1 day but does not require process hours			
7	Outdoor Marshall 2	Evacuation truck's docking	Around 10 min	10	66	0.15
8	Indoor Marshall 2	Cell A dock door's opening	Around 5 min	5	66	0.08
9	Pit dock / Cell A	Pallets' transfert from storing stages to the trailer for exit	Around 30 min	30	66	0.45
10	Indoor Marshall 2	Cell A dock door's closing	Around 5 min	5	66	0.08
11	Outdoor Marshall 2	Truck's exit from LIL1	Around 15 min	15	66	0.23
			Total temps max	76		7.73

Table A.1: Total processing time results:

From D Cell	Max process time	Pallets' number	Process time for 1 pallet
Max total process time (min)	89		15.73
Max total process time (hour)	1.48		0.26
Process time to load 1 truck (hours)		66	17.31

From F Cell	Max process time	Pallets' number	Process time for 1 pallet
Max total process time (min)	232		15.37
Max total process time (hour)	3.87		0.26
Process time to load 1 truck (hours)		66	16.91

Annex B – Totes volumes data

Table B. 1: 2023's data

		Q1				Q2				Q3				Q4			
	Weeks	2023-01	2023-05	2023-09	2023-13	2023-14	2023-18	2023-22	2023-26	2023-27	2023-31	2023-35	2023-39	2023-40	2023-44	2023-48	2023-52
Starting Data	tote_percent	53,0%	43,0%	37,5%	53,9%	59,3%	67,4%	59,0%	51,2%	50,1%	62,3%	61,8%	56,7%	54,2%	63,4%	57,6%	73,3%
	Total TSI Volumes	1 172 744	838 439	511 308	406 849	632 803	221 886	945 685	741 491	874 716	940 985	891 347	1 069 513	976 713	696 444	1 985 226	786 802
	Sum per trimester	10 387 266				8 383 059				12 545 509				17 198 913			
	Average Percentage Totes	48,1%				59,0%				58,5%				57,3%			
	Average volume per Totes	20,50				19,59				15,40				15,83			
	Total Items from Totes	5001389				4942265				7336807				9854183			
	Total Totes	243949				252319				476362				622305			
	Pallet number	6099				6308				11909				15558			
Totes volumes from TSI (without TSO's needs)	Items from totes volume	620968	360277	191485	219292	375505	149485	557481	379347	437970	586516	550407	606414	529378	441406	1143887	577041
	Average Units per totes	23,3	19,7	21,1	20,5	20,5	21,8	19,8	17,1	24,2	12,8	11,6	14,2	15,8	14,8	15,5	14,4
	Average Totes per week	26632	18297	9087	10685	18334	6852	28209	22218	18061	45686	47275	42595	33556	29894	73579	40161
	Work days/ week	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Average Totes volume per day	5326	3659	1817	2137	3667	1370	5642	4444	87594	117303	110081	121283	105876	88281	228777	115408
	Average Totes volume per shift	2663	1830	909	1068	1833	685	2821	2222	43797	58652	55041	60641	35292	29427	76259	38469
	Average Totes volume per hour	392	269	134	157	270	101	415	327	6441	8625	8094	8918	5190	4328	11215	5657
	Pallet number per hour	9,8	6,7	3,3	3,9	6,7	2,5	10,4	8,2	161,0	215,6	202,4	222,9	129,7	108,2	280,4	141,4
Totes from TSI - TSO totes need	TSO volumes	205318	248788	137640	71918	67794	104967	156761	112407	123243	95413	113533	159293	246592	443881	506066	354264
	Totes used by TSO (based on average units per TSI Totes)	8806	12635	6532	3504	3310	4812	7932	6584	5082	7432	9751	11189	15631	30062	32552	24656
	Totes from TSI - TSO totes need per week	17826	5662	2555	7181	15024	2041	20277	15635	12979	38254	37523	31406	17925	-168	41027	15505
	Corrected Average TSI totes per day	3565	1132	511	1436	3005	408	4055	3127	2596	7651	7505	6281	3585	-34	8205	3101
	Corrected Average Totes per Shift	1783	566	256	718	1502	204	2028	1563	1298	3825	3752	3141	1195	-11	2735	1034
	Corrected Totes evacuation need per hour	262	83	38	106	221	30	298	230	191	563	552	462	176	-2	402	152
	EBTS pallets to be evacuated per hour	6,6	2,1	0,9	2,6	5,5	0,8	7,5	5,7	4,8	14,1	13,8	11,5	4,4	0,0	10,1	3,8
	EBTS pallets to be evacuated per shift	44,6	14,2	6,4	18,0	37,6	5,1	50,7	39,1	32,4	95,6	93,8	78,5	29,9	-0,3	68,4	25,8
	EBTS pallets to be evacuated per day	89,1	28,3	12,8	35,9	75,1	10,2	101,4	78,2	64,9	191,3	187,6	157,0	89,6	-0,8	205,1	77,5
	EBTS pallets to be evacuated per week	445,7	141,6	63,9	179,5	375,6	51,0	506,9	390,9	324,5	956,4	938,1	785,1	448,1	-4,2	1025,7	387,6
	EBTS pallets to be evacuated per Quartiles	3067,6				3571,0				9897,8				7054,3			

	Average	Total
tote_percent	0,56	
Total TSI Volumes per week	932975,90	48 514 747
Sum per trimester	12128686,75	48 514 747
Average Percentage Totes per trimester	0,56	2
Average volume per Totes per trimester	17,83	71
Total Items from Totes per trimester	6783660,84	27 134 643
Total Totes per trimester	398733,59	1 594 934
Pallet number per trimester	9968,34	39 873
Items from totes volume per	518194,38	26 946 108
Average Units per totes	17,83	927
Average Totes per week	31118,56	1 618 165
Work days/ week	5,00	260
Average Totes volume per day	67611,12	3 515 778
Average Totes volume per shift	27551,33	1 432 669
Average Totes volume per hour	4051,67	210 687
Pallet number per hour	101,29	5 267
TSO volumes	219593,81	11 418 878
Totes used by TSO (based on average units per TSI Totes)	12971,88	674 538
Totes from TSI - TSO totes need per week	18146,68	943 628
Corrected Average TSI totes per day	3629,34	188 726
Corrected Average Totes per Shift	1633,79	84 957
Corrected Totes evacuation need per hour	240,26	12 494
EBTS pallets to be evacuated per hour	6,01	312
EBTS pallets to be evacuated per shift	40,84	2 124
EBTS pallets to be evacuated per day	90,73	4 718
EBTS pallets to be evacuated per week	453,67	23 591
EBTS pallets to be evacuated per Quartiles	5897,67	23 591

Estimation EBTS pallets processing hours for 2023

		Q1				Q2				Q3				Q4			
	Weeks	2023-01	2023-05	2023-09	2023-13	2023-14	2023-18	2023-22	2023-26	2023-27	2023-31	2023-35	2023-39	2023-40	2023-44	2023-48	2023-52
Per hours	Pallets from Cell F	0,84	0,27	0,12	0,34	0,71	0,10	0,95	0,74	0,61	1,80	1,77	1,48	0,56	0,00	1,29	0,49
	Pallets from Cell D	0,86	0,27	0,12	0,35	0,72	0,10	0,98	0,75	0,63	1,84	1,81	1,51	0,58	0,00	1,32	0,50
Per shifts	Pallets from Cell F	5,71	1,81	0,82	2,30	4,81	0,65	6,49	5,01	4,16	12,25	12,02	10,06	3,83	0,00	8,76	3,31
	Pallets from Cell D	5,84	1,86	0,84	2,35	4,92	0,67	6,65	5,13	4,25	12,54	12,30	10,30	3,92	0,00	8,97	3,39
Per days	Pallets from Cell F	11,42	3,63	1,64	4,60	9,62	1,31	12,99	10,01	8,31	24,50	24,03	20,11	11,48	0,00	26,28	9,93
	Pallets from Cell D	11,69	3,71	1,68	4,71	9,85	1,34	13,29	10,25	8,51	25,08	24,60	20,59	11,75	0,00	26,90	10,17
Per weeks	Pallets from Cell F	57,09	18,13	8,18	22,99	48,11	6,54	64,93	50,07	41,56	122,50	120,16	100,57	57,40	0,00	131,38	49,65
	Pallets from Cell D	58,44	18,56	8,38	23,54	49,25	6,69	66,47	51,25	42,55	125,40	123,00	102,95	58,76	0,00	134,49	50,83
Per quartiles	Pallets from Cell F	392,94				457,42				1267,85				903,61			
	Pallets from Cell D	402,23				468,24				1297,84				924,99			

	Average	Total	Cost	
Pallets from Cell F	0,77		24,62	
Pallets from Cell D	0,79		25,21	
Pallets from Cell F	5,23		167,44	
Pallets from Cell D	5,36		171,41	
Pallets from Cell F	11,62		371,98	
Pallets from Cell D	11,90		380,78	
Pallets from Cell F	58,12	3 022	1859,91	96715,17
Pallets from Cell D	59,50	3 094	1903,91	99003,16
Pallets from Cell F	755,45	3 022	24174,50	96697,99
Pallets from Cell D	773,32	3 093	24746,39	98985,57

Table B. 2: Solutions' results

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Estimation EBTS pallets processing hours for 2023 with solution 2

		Q1				Q2				Q3				Q4			
	Weeks	2023-01	2023-05	2023-09	2023-13	2023-14	2023-18	2023-22	2023-26	2023-27	2023-31	2023-35	2023-39	2023-40	2023-44	2023-48	2023-52
Per hours	Pallets from Cell F	0.56	0.18	0.08	0.23	0.47	0.06	0.64	0.49	0.41	1.21	1.18	0.99	0.38	0.00	0.86	0.33
	Pallets from Cell D	0.57	0.18	0.08	0.23	0.48	0.07	0.65	0.50	0.42	1.23	1.21	1.01	0.38	0.00	0.88	0.33
Per shifts	Pallets from Cell F	3.83	1.22	0.55	1.54	3.22	0.44	4.35	3.36	2.79	8.21	8.05	6.74	2.57	0.00	5.87	2.22
	Pallets from Cell D	3.89	1.24	0.56	1.57	3.28	0.45	4.43	3.42	2.84	8.36	8.20	6.86	2.61	0.00	5.97	2.26
Per days	Pallets from Cell F	7.65	2.43	1.10	3.08	6.45	0.88	8.70	6.71	5.57	16.42	16.11	13.48	7.70	0.00	17.61	6.66
	Pallets from Cell D	7.79	2.47	1.12	3.14	6.56	0.89	8.86	6.83	5.67	16.71	16.39	13.72	7.83	0.00	17.92	6.77
Per weeks	Pallets from Cell F	38.26	12.15	5.48	15.41	32.25	4.38	43.52	33.56	27.86	82.11	80.54	67.41	38.48	0.00	88.06	33.28
	Pallets from Cell D	38.94	12.37	5.58	15.68	32.82	4.46	44.29	34.15	28.35	83.56	81.96	68.60	39.15	-0.37	89.62	33.87
Per quartiles	Pallets from Cell F	263.38				306.60				849.81				605.67			
	Pallets from Cell D	268.02				312.01				864.81				616.36			

	Average	Total	Cost	
Pallets from Cell F	0.52		16.51	
Pallets from Cell D	0.52		16.80	
Pallets from Cell F	3.51		112.23	
Pallets from Cell D	3.57		114.22	
Pallets from Cell F	7.79		249.33	
Pallets from Cell D	7.93		253.73	
Pallets from Cell F	**38.96**	2 026	**1246.66**	64826.33
Pallets from Cell D	**39.64**	2 061	**1268.43**	65958.61
Pallets from Cell F	506.37	2 025	16203.71	**64814.82**
Pallets from Cell D	515.30	2 061	16489.65	**65958.61**

Hours gained with solution 2

		Q1				Q2				Q3				Q4			
	Weeks	2023-01	2023-05	2023-09	2023-13	2023-14	2023-18	2023-22	2023-26	2023-27	2023-31	2023-35	2023-39	2023-40	2023-44	2023-48	2023-52
Per hours	Pallets from Cell F	0.28	0.09	0.04	0.11	0.23	0.03	0.31	0.24	0.20	0.59	0.58	0.49	0.19	0.00	0.42	0.16
	Pallets from Cell D	0.29	0.09	0.04	0.12	0.24	0.03	0.33	0.25	0.21	0.62	0.60	0.51	0.19	0.00	0.44	0.17
Per shifts	Pallets from Cell F	1.88	0.60	0.27	0.76	1.59	0.22	2.14	1.65	1.37	4.04	3.96	3.32	1.26	0.00	2.89	1.09
	Pallets from Cell D	1.95	0.62	0.28	0.79	1.64	0.22	2.22	1.71	1.42	4.18	4.10	3.44	1.31	0.00	2.99	1.13
Per days	Pallets from Cell F	3.76	1.20	0.54	1.52	3.17	0.43	4.28	3.30	2.74	8.08	7.92	6.63	3.79	0.00	8.66	3.27
	Pallets from Cell D	3.90	1.24	0.56	1.57	3.29	0.45	4.44	3.42	2.84	8.37	8.21	6.87	3.92	0.00	8.97	3.39
Per weeks	Pallets from Cell F	18.82	5.98	2.70	7.58	15.86	2.15	21.41	16.51	13.70	40.39	39.62	33.16	18.93	0.00	43.32	16.37
	Pallets from Cell D	19.50	6.19	2.79	7.85	16.43	2.23	22.18	17.10	14.20	41.84	41.04	34.35	19.61	0.37	44.87	16.96
Per quartiles	Pallets from Cell F	129.56				150.82				418.03				297.94			
	Pallets from Cell D	134.21				156.23				433.03				308.63			

	Average	Total	Financial gains		Percentage
Pallets from Cell F	0.25		8.12		33%
Pallets from Cell D	0.26		8.41		33%
Pallets from Cell F	1.73		55.21		33%
Pallets from Cell D	1.79		57.19		33%
Pallets from Cell F	3.83		122.65		33%
Pallets from Cell D	3.97		127.05		33%
Pallets from Cell F	**19.16**	997	**613.25**	31 888.84	33%
Pallets from Cell D	**19.86**	1033	**635.47**	33 044.55	33%
Pallets from Cell F	249.09	996	7 970.79	**31 883.17**	33%
Pallets from Cell D	258.02	1032	8 256.74	**33 026.96**	33%
			Total	64910.14	

Estimation EBTS pallets processing hours for 2023 with solution 3 (East PT)

		Q1				Q2				Q3				Q4			
	Weeks	2023-01	2023-05	2023-09	2023-13	2023-14	2023-18	2023-22	2023-26	2023-27	2023-31	2023-35	2023-39	2023-40	2023-44	2023-48	2023-52
Per hour	Pallets from Cell F	0.45	0.14	0.06	0.18	0.38	0.05	0.51	0.39	0.33	0.96	0.94	0.79	0.30	0.00	0.69	0.26
Per shifts	Pallets from Cell F	3.05	0.97	0.44	1.23	2.57	0.35	3.47	2.67	2.22	6.54	6.42	5.37	2.04	0.00	4.68	1.77
Per days	Pallets from Cell F	6.10	1.94	0.87	2.46	5.14	0.70	6.94	5.35	4.44	13.09	12.84	10.75	6.13	0.00	14.04	5.31
Per weeks	Pallets from Cell F	30.50	9.69	4.37	12.29	25.70	3.49	34.69	26.75	22.21	65.45	64.20	53.73	30.67	0.00	70.19	26.53
Per quartiles	Pallets from Cell F	209.93				244.38				677.35				482.76			

	Average	Total	Cost	
Pallets from Cell F	0.41		13.16	
Pallets from Cell F	2.80		89.46	
Pallets from Cell F	6.21		198.73	
Pallets from Cell F	**31.05**	1615	**993.66**	51670.40
Pallets from Cell F	403.60	1614	12915.31	**51 661.22**

Hours gained by solution 3

		Q1				Q2				Q3				Q4			
	Weeks	2023-01	2023-05	2023-09	2023-13	2023-14	2023-18	2023-22	2023-26	2023-27	2023-31	2023-35	2023-39	2023-40	2023-44	2023-48	2023-52
Per hour	Pallets from Cell F	0.39	0.12	0.06	0.16	0.33	0.04	0.44	0.34	0.28	0.84	0.82	0.69	0.26	0.00	0.60	0.23
Per shifts	Pallets from Cell F	2.66	0.84	0.38	1.07	2.24	0.30	3.02	2.33	1.94	5.71	5.60	4.68	1.78	0.00	4.08	1.54
Per days	Pallets from Cell F	5.32	1.69	0.76	2.14	4.48	0.61	6.05	4.66	3.87	11.41	11.19	9.37	5.35	0.00	12.24	4.62
Per weeks	Pallets from Cell F	26.59	8.45	3.81	10.71	22.41	3.04	30.24	23.32	19.36	57.06	55.97	46.84	26.73	0.00	61.19	23.12
Per quartiles	Pallets from Cell F	183.01				213.04				590.50				420.85			

	Average	Total	Financial gains		Percentage
Pallets from Cell F	0.36		11.47		47%
Pallets from Cell F	2.44		77.99		47%
Pallets from Cell F	5.41		173.25		47%
Pallets from Cell F	**27.07**	1408	**866.25**	45 044.77	47%
Pallets from Cell F	351.85	1407	11259.19	**45 036.77**	47%
			Total	90081.54	

Annex C – East PT circling area layout

Figure C. 1: Former layout

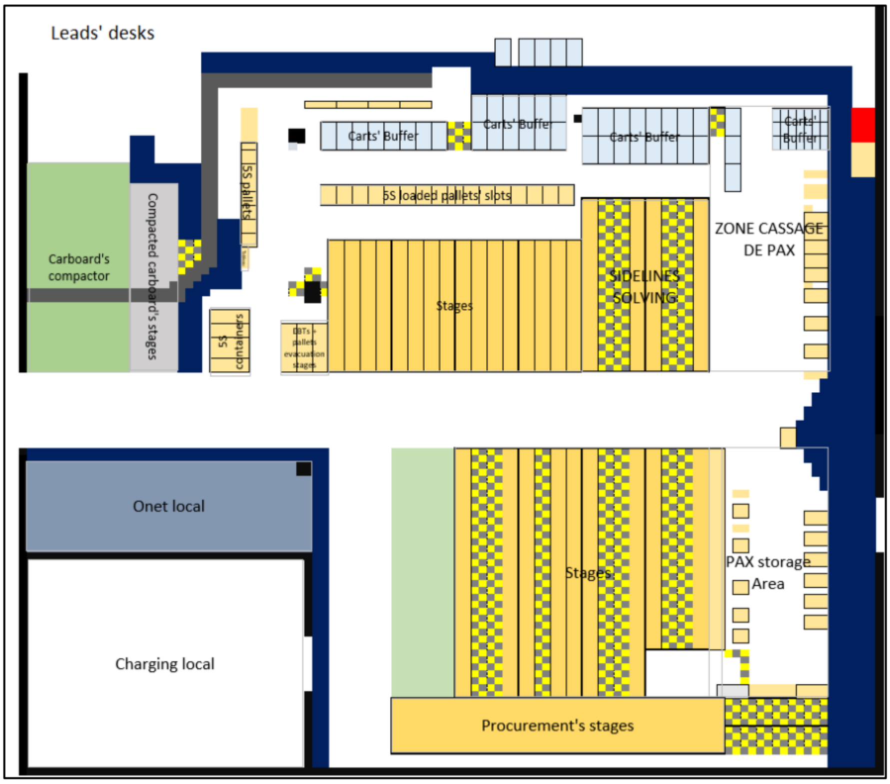


Figure C. 2: New layout

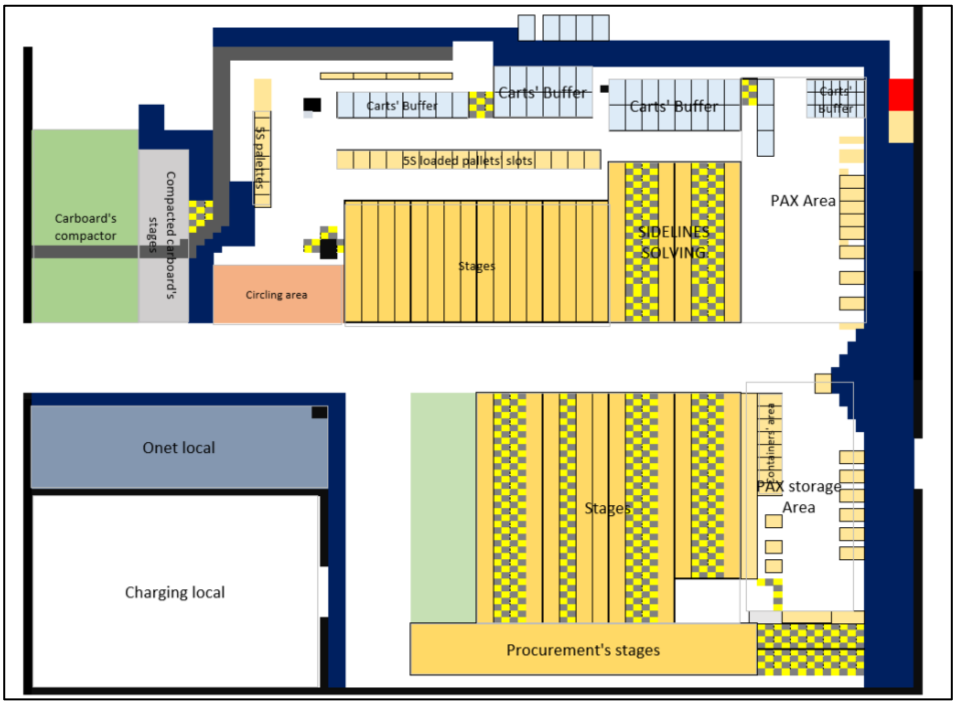
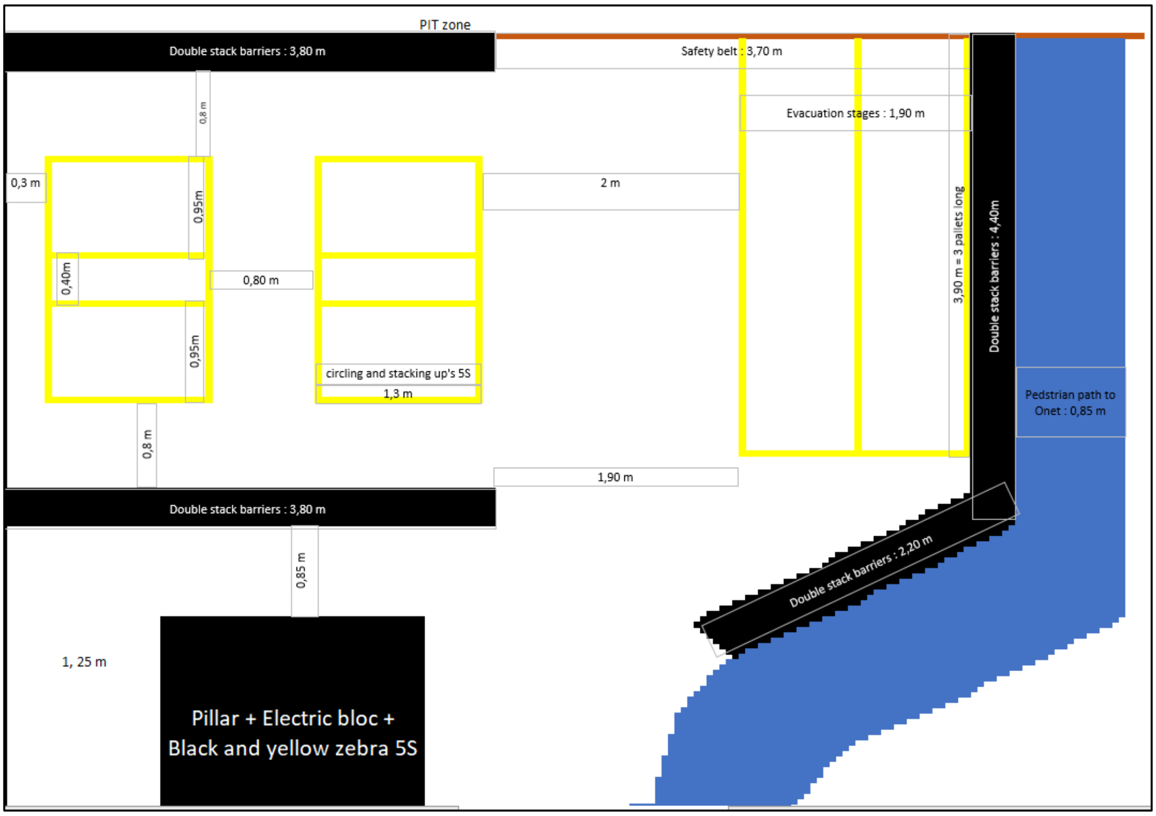


Figure C. 3: Close up on the new circling zone



Annex D – Solutions organization's details

Figure D. 1: Solution 1 - circling + stacking up of pallets in non-prep pallets' stages, Cell A

From Cell D

Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Associates	Loading U-boats with EBTs	Depending number of Aas and Totes to be stowed		1	0
2	IDRTs	Transfert EBTs on pallets	2,5 - 3 min	3	1	3
3	Pit dock	Transfert pallets to Cell A	5 min	5	2	2.5
4	Pit dock	Way back from Cell A	5 min	5	2	2.5
			Total	13		8

From Cell F

Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Associates	Loading U-boats with EBTs	Depending number of Aas and Totes to be stowed		1	0.00
2	IDRTs	Transfert EBTs on pallets	2,5 - 3 min	3	1	3.00
3	Kamag	Empty trailer's transit	Around 30 min	30	33	0.91
4	Outdoor Marshall	Trailer's docking at the Inbdound Docks	Around 10 min	10	33	0.30
5	Indoor Marshall	Docks door's opening	Around 3 min	3	33	0.09
6	Pit dock	Pallets' tranfert to the trailer	Around 30 min	30	33	0.91
7	Indoor Marshall	Docks door's closing	Around 5 min	5	33	0.15
8	Kamag	Transit of loaded trailer to Cell A	Around 30 min	30	33	0.91
9	Outdoor Marshall 2	Trailer's docking in Cell A	Around 10 min	10	33	0.30
10	Indoor Marshall 2	Cell A door's opening	Around 5 min	5	33	0.15
11	Pit docks / Cell A	Pallets' unloading + non-prep pallets's stored in stages	Around 30 min for 1 AA	30	33	0.91
			Total	156		7.64

In Cell A

Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	AA responsible of circling	Pallets' circling	Around 1 min	1	1	1.00
2	AA responsible of circling	Stacking up of circled pallets	2-3 min	3	2	1.50
3	AA responsible of circling	Circling of stacked up pallets	Around 1 min	1	2	0.50
4	Pit dock / Cell A	Proccessed pallets' transfert to storing stages	Around 3 min	3	4	0.75
5	Pit dock / Cell A	Storing of processed pallets in Cell A, awaiting for the evacuation's truck arrivals	Around 1 day but does not require process hours			
6	Outdoor Marshall 2	Evacuation truck's docking	Around 10 min	10	66	0.15
7	Indoor Marshall 2	Cell A dock door's opening	Around 5 min	5	66	0.08
8	Pit dock / Cell A	Pallets' transfert from storing stages to the trailer for exit	Around 30 min	30	66	0.45
9	Indoor Marshall 2	Cell A dock door's closing	Around 5 min	5	66	0.08
10	Outdoor Marshall 2	Truck's exit from LIL1	Around 15 min	15	66	0.23
			Total	73		4.73

From Cell D

	Max process time	Pallets' number	Process time for 1 pallet
Max total process time (min)	86		12.73
Max total process time (hour)	1.43		0.21
Process time to load 1 truck (hours)		66	14.01

From Cell F

	Max process time	Pallets' number	Process time for 1 pallet
Max total process time (min)	229		12.37
Max total process time (hour)	3.82		0.21
Process time to load 1 truck (hours)		66	13.61

Hours saved by truck	
From Cell D	3.30
From Cell F	3.30

Figure D. 2: Solution 2 - circling + stacking up of pallets in PTs and evacuation from Cell A

From Cell D

Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Associates	Loading U-boats with EBTs	Depending number of Aas and Totes to be stowed		1	0.00
2	IDRTs	Transfert EBTs on pallets	2,5 - 3 min	3	1	3.00
3	IDRTs	Transfert pallets in D's circling-stacking up zone	Around 2 min	2	2	1.00
4	IDRTs	Circling of individual pallets	Around 1 min	1	1	1.00
5	IDRTs	Pallets' stacking	2-3 min	3	2	1.50
6	IDRTs	Stacked pallets' circling	Around 1 min	1	2	0.50
7	Pit dock	Pallets' transfer to Cell A	5 min	5	4	1.25
8	Pit dock	Way back from Cell A	5 min	5	4	1.25
			Total	20		9.50

From Cell F

Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Associates	Loading U-boats with EBTs	Depending number of Aas and Totes to be stowed		1	0.00
2	IDRTs	Transfert EBTs on pallets	2,5 - 3 min	3	1	3.00
3	IDRTs	Transfert pallets in D's circling-stacking up zone	Around 2 min	2	2	1.00
4	IDRTs	Circling of individual pallets	Around 1 min	1	1	1.00
5	IDRTs	Pallets' stacking	2-3 min	3	2	1.50
6	IDRTs	Stacked pallets' circling	Environ 1 min	1	2	0.50
7	Kamag	Empty trailer's transit	Around 30 min	30	66	0.45
8	Outdoor Marshall	Trailer's docking at the Inbdound Docks	Around 10 min	10	66	0.15
9	Indoor Marshall	Docks door's opening	Around 3 min	3	66	0.05
10	Pit dock	Pallets' tranfert to the trailer	Around 30 min	30	66	0.45
11	Indoor Marshall	Docks door's closing	Around 5 min	5	66	0.08
12	Kamag	Transit of loaded trailer to Cell A	Around 30 min	30	66	0.45
13	Outdoor Marshall 2	Trailer's docking in Cell A	Around 10 min	10	66	0.15
14	Indoor Marshall 2	Cell A door's opening	Around 5 min	5	66	0.08
15	Pit dock / Cell A	Pallets' unloading + pallets stored in stages	Around 30 min for 1 AA	30	66	0.45
			Total	163		9.32

In Cell A

Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Pit dock / Cell A	Storing of processed pallets in Cell A, awaiting for the evacuation's truck arrivals	Around 1 day but does not require process hours			
2	Outdoor Marshall 2	Evacuation truck's docking	Around 10 min	10	66	0.15
3	Indoor Marshall 2	Cell A dock door's opening	Around 5 min	5	66	0.08
4	Pit dock / Cell A	Pallets' transfert from storing stages to the trailer for exit	Around 30 min	30	66	0.45
5	Indoor Marshall 2	Cell A dock door's closing	Around 5 min	5	66	0.08
6	Outdoor Marshall 2	Truck's exit from LIL1	Around 15 min	15	66	0.23
			Total	65		0.98

From Cell D

	Max process time	Pallets' number	Process time for 1 pallet
Max total process time (min)	85		10.48
Max total process time (hour)	1.42		0.17
Process time to load 1 truck (hours)		66	11.53

From Cell F

	Max process time	Pallets' number	Process time for 1 pallet
Max total process time (min)	228		10.30
Max total process time (hour)	3.80		0.17
Process time to load 1 truck (hours)		66	11.33

Hours saved by truck	
From Cell D	5.78
From Cell F	5.58

Figure D. 3: Solution 3 - similar to solution 2 but evacuation of Totes from West PT in Cell A and of Totes from East PT in Inbound's Docks

From Cell D

Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Associates	Loading U-boats with EBTs	Depending number of Aas and Totes to be stowed		1	0.00
2	IDRTs	Transfert EBTs on pallets	2,5 - 3 min	3	1	3.00
3	IDRTs	Transfert pallets in D's circling-stacking up zone	Around 2 min	2	2	1.00
4	IDRTs	Circling of individual pallets	Around 1 min	1	1	1.00
5	IDRTs	Pallets' stacking	2-3 min	3	2	1.50
6	IDRTs	Stacked pallets' circling	Around 1 min	1	2	0.50
7	Pit dock	Pallets' transfer to Cell A	5 min	5	4	1.25
8	Pit dock	Way back from Cell A	5 min	5	4	1.25
			Total	20		9.50

In Cell A

Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Pit dock / Cell A	Storing of processed pallets in Cell A, awaiting for the evacuation's truck arrivals	Around 1 day but does not require process hours			
2	Outdoor Marshall 2	Evacuation truck's docking	Around 10 min	10	66	0.15
3	Indoor Marshall 2	Cell A dock door's opening	Around 5 min	5	66	0.08
4	Pit dock / Cell A	Pallets' transfert from storing stages to the trailer for exit	Around 30 min	30	66	0.45
5	Indoor Marshall 2	Cell A dock door's closing	Around 5 min	5	66	0.08
6	Outdoor Marshall 2	Truck's exit from LIL1	Around 15 min	15	66	0.23
			Total	65		0.98

From Cell D

	Max process time	Pallets' number	Process time for 1 pallet
Max total process time (min)	85		10.48
Max total process time (hour)	1.42		0.17
Process time to load 1 truck (hours)		66	11.53

From Cell F

Step	Who	What	Time	Maximum time	Number of pallets	Max. time per pallet
1	Associates	Loading U-boats with EBTs	Depending number of Aas and Totes to be stowed		1	0.00
2	IDRTs	Transfert EBTs on pallets	2,5 - 3 min	3	1	3.00
3	IDRTs	Transfert pallets in D's circling-stacking up zone	Around 2 min	2	2	1.00
4	IDRTs	Circling of individual pallets	Around 1 min	1	1	1.00
5	IDRTs	Pallets' stacking	2-3 min	3	2	1.50
6	IDRTs	Stacked pallets' circling	Around 1 min	1	2	0.50
9	Outdoor Marshall	Trailer's docking at the Inbdound Docks	Around 10 min	10	66	0.15
10	Indoor Marshall	Docks door's opening	Around 3 min	3	66	0.05
7	IDRTs	Pallets' transfer in a trailer, until truck's pick up	Around 30 min		66	0.00
11	Pit dock	Arrival of the truck and pick up of the trailer	Around 1 day but does not require process hours	45	66	0.68
12	Indoor Marshall	Docks door's closing	Around 5 min	5	66	0.08
13	Outdoor Marshall	Truck's exit from LIL1	Around 15 min	15	66	0.23
			Total	88		8.18

From Cell F

	Max process time	Pallets' number	Process time for 1 pallet
Max total process time (min)	88		8.18
Max total process time (hour)	1.47		0.14
Process time to load 1 truck (hours)		66	9.00

Hours saved by truck	
From Cell D	5.78
From Cell F	7.91