The integration of an automated planning system at a liner shipping company

Optimizing the planning of empty containers by the use of a new technology tool

MSc Thesis Complex Systems Engineering and Management

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by

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Preface

With the writing of this foreword, my time as a student at TU Delft also comes to an end. By presenting this thesis, I am concluding six years of study at the Faculty of Technology, Policy and Management with a personal milestone. Not only have I learned a lot about myself over the past years, but I have also become significantly wiser in academic terms. The combination of new technologies and complex systems, focusing on logistics, has fascinated and excited me more each year. This enthusiasm has also been reflected in the writing of this thesis. No matter how straightforward a problem or outcome may sometimes seem, truly getting to the core can be challenging in complex systems, a challenge I have embraced in this thesis.

Of course, I could not have done this without the proper guidance. From TU Delft, I would like to thank Ron van Duin for the update meetings where, sometimes with few words, I was kept on the right research path. Additionally, I would like to thank Mark de Bruijne and Lori Tavasszy for the valuable and interesting feedback and recommendations. As my graduation committee from TU Delft, the combination of you all has certainly contributed to my enjoyment and insights during this process.

Joost van Wilsum, my company supervisor from Maersk, certainly should not be forgotten and whose guidance deserves extra attention. The help you provided when needed and your involvement with the right people have greatly contributed to the research's outcome and the enjoyment of the writing process. Your guidance is greatly appreciated and will definitely be remembered as a pleasant part of writing my thesis.

My colleagues at Maersk also deserve a word of thanks for their willingness to share their knowledge, opinions, and experiences. The readiness to always help is greatly appreciated. I would like to specifically thank my direct colleagues from the equipment department in Rotterdam for the pleasant atmosphere in the office and for helping me improve my table tennis skills over the past few months.

Lastly, I would like to thank my friends and family for their unconditional support during this process. Your interest and often much-needed moral support have made writing this report easier. I believe it is appropriate to give a special word of thanks to Knut, considering the stressful moments I may have unjustly taken out on you at times. Thank you for always being there for me!

I hope that my thesis not only contributes to optimizing the process of moving empty containers for Maersk but also provides valuable insights into addressing adoption challenges in complex systems in general.

Claire Arentsen
Delft, June 2024

Summary

Due to global trade imbalances, empty containers are stored in depots awaiting repositioning to facilitate new trade. Shipping companies bear these operational costs since no customer directly pays for these repositioning moves. Therefore, the objective is to keep the number of repositioning moves of empty containers to a minimum. Literature shows that optimizing the planning of these moves can be done via the integration of an automated planning system based on an optimization algorithm. Nevertheless, to date, no examples of successful implementations have been identified. As a result, this study researched the implementation of an automated planning system via the following research question: *"What are the adoption barriers and enablers for implementing an automated planning system in the planning of the empty container flow at a liner shipping company?"*

Research based on a qualitative analysis is conducted to reveal users' associations with the automated planning system and its adoption rate. An exploratory approach is used since no research on this topic specified in the maritime industry has been performed. To demonstrate practical relevance, the case of the lagging adoption rate of Maersk's automated planning system was central to this study. To conduct structured research on the adoption problem of this planning system, the Technology Acceptance Model (TAM) of Davis is used [23]. The objective of this model is to identify the relevant characteristics of the planning system that influence the adoption rate. Not only is the relevance of the identified system characteristics assessed, but also the perspectives on them were researched through a survey of planners of empty containers. The use and analysis of the survey results also afford a quantitative dimension to the study.

Analysis of the survey results of equipment planners globally shows that all eight identified system characteristics are important to equipment planners when adopting a new technology system in general. However, the output quality of a system is found to be the most critical system characteristic. These results align with equipment planners' perspectives on the automated planning system central in this study. Comparing perspectives based on the system characteristics with each other, perspectives related to the system's output quality have the lowest average score. A closer examination of the criteria of this characteristic reveals a number of additional factors that can be considered influential to the perceived output quality of the system. As a result, the following adoption barriers can be identified: the mismatch between the designed system and the way equipment planners create their repositioning plans, the lack of understanding of the required inputs the system needs and the output it is generating, and a missing point of contact to address problems related to the automated planning system.

A road map has been drafted to overcome these barriers and improve the system's adoption rate. Five clear points of action focus on improving the system's output quality and reducing resistance. The system's intended users, the equipment planners, are central to these points. The first step will highlight the added value of the automated planning system over manually creating a repositioning plan to the equipment planners. The second step focuses on the functioning of an algorithm in general to show the importance of the input data given to a planning system. It is expected that these steps will initiate the reduction of resistance. The following step will improve the quality of the system itself. This can be achieved by designating a focal point per operational region, which will form the missing link between the users and developers of the system. The fourth step recommends presenting improvements made to the system to increase confidence in the system. The final step will focus on improving the use of the system by presenting the constraints used by the planning system to arrive at the suggested repositioning move.

The research results demonstrate that while a system's output quality may be perceived as a barrier to adoption, several additional factors also influence this system characteristic. These findings may not have been found had the research been conducted with a direct focus on the system's output. This study shows that using the system characteristics of the TAM is suitable for this end. However, additional re-

search is needed on these characteristics. The systematic approach followed in this study presents a systematic way of analyzing an adoption problem and eventually identifying the root cause of a lagging adoption problem when using the TAM. This approach could be generally used on other adoption problems in the maritime sector or adoption problems of new systems in general.

Although clear barriers to the system's adoption have been identified, no focus has been given to the possible correlations between the identified system characteristics, which can be seen as a limitation of the study. Furthermore, the perspectives of the system characteristics on the system central have been obtained through a survey. Even though this method is suitable for gathering information from a large cohort at once, it cannot capture the latent thoughts of participants on the perspectives. Therefore, this can also be seen as a limitation of the study.

Three recommendations can be proposed for further research. The first one is following from the limitation previously described. Given that no attention has been given to the possible correlations of the system characteristic, it is proposed that this be included in future research where the same approach is followed. In addition, it is also recommended that the demographics of the participants be included when analyzing the results. This was not relevant to the study present but can have implications for other adoption problems. The last recommendation for further research is applicable to the company central in this case study. No attention has yet been given to the possible changing role of an equipment planner; however, it is anticipated that when the automated planning system reaches optimal functionality, this role will evolve into a more analyst one. This possible shift needs to be researched in the future.

In conclusion, this study's findings provide a clear and supported answer to the main research question. The list of adoption barriers and road map with enablers provide sufficient tools to improve the adoption rate of Maersk's automated planning system, which will decrease the operational cost spent on repositioning empty containers. Furthermore, this study presents a systematic approach to identifying the root cause of adoption problems, which can be generally applied.

Contents

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List of Acronyms

Acronym	Definition
AFR	Africa region
AMR	Americas region
APA	Asia Pacific region
DOI	Diffusion of Innovations Theory
EUR	Europe region
IME	India, Middle East and Africa Region
OTT	Order To Transport
PLP system	Pool-Level-Planning system
RoFo	Rolling Forecast
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TSL	Target Stock Level
UTAUT	Unified Theory of Acceptance and Use of Technology

1 Research set up

1.1. Introduction

Around 80% of goods around the globe are estimated to be transported overseas, making the shipping industry the main pillar of international trade [48]. This container flow is determined by the global supply and demand of containerized goods. The optimal flow exists when supply and demand worldwide are perfectly balanced. However, trade imbalances have been an enduring factor in maritime shipping and require the repositioning of empty containers across major shipping lanes [73]. The repositioning of empty containers even constitutes the largest proportion within the global container traffic industry [46]. Already in 2016, 20.5% of the world's total port turnover referred to empty containers, and 2.5 million containers were stored empty at container depots worldwide, this number has only grown over the past years [72].

Moving an empty container still results in operational costs; however, since no customer is directly paying for the movement, carriers incur the cost of storage and repositioning themselves and later reflect these costs in shipping rates, as could be seen during the COVID pandemic [73]. Due to the complete lockdown in some countries, there was a huge imbalance in positioning empty containers that needed to be re-positioned when the demand for goods increased in the second quarter of 2020, resulting in the highest shipping rates ever. Where pre-pandemic, a container from China to the west coast of America cost only $1400, during the pandemic, this rose to a record of $20,600, which was passed on throughout the whole supply chain till the end consumers [83]. After the pandemic ended two years ago, the repositioning of empty containers and costs reflecting is still an industry-wide problem with many aspects to it [85].

Planning the empty container flow is of great importance for international trade balance. Implementing and adopting new digital technology tools can help solve some of the challenges that arise when planning the movement of empty containers [73]. Even in today's digitized world, most planning is still done manually in Excel [85]. A literature review was conducted to better understand the implementation and adoption of a new technology tool.

1.2. Literature review

The method used for this review, the selected articles and some core concepts are elaborated on in appendix A. The main findings of these reviewed articles will be discussed in this section.

A number of studies have shown that an automated planning system can be effective in optimizing the container flow. These models are also referred to as network flow optimisation models. Already in 2007, Li et al. published their research where the multi-port empty container allocation problem is optimized with a heuristic algorithm. This algorithm uses optimal policies to compute the specific allocation of empty containers between ports [50]. Brouer et al. (2011) take this further and present a mathematical model for the cargo allocation problem with empty repositioning in their paper [12]. Their model can be used to strategically evaluate a liner shipping network and select the most profitable cargo contracts given the derived empty repositioning and equipment leasing cost. Using this model will maximize the profit of shipping companies. Abdelshafie et al. (2023) also take the current, inefficient way of creating repositioning plans as the initiation of their research. They have integrated the agent-based modelling paradigm to model the movements of empty containers for maritime shipping routes between ports in the Middle East and Asia for the CMA-CGM shipping line [2]. Song and Dong (2012) have created a model close to reality, where the problem of joint cargo routing and empty container repositioning at the operational level for a shipping network with multiple service routes, multiple deployed vessels and multiple regular voyages is created [77]. Lastly, Zhang et al. (2014) consider the repositioning of empty containers between multi-ports over multi-periods with stochastic demand and loss by creating a mathematical model where the objective is to minimize total operating cost [102].

Even though these studies have developed several algorithms optimizing the planning, and many others have focused on the technological adoption of such, there are limited to no success stories about the change to an automated empty container planning [62] [28]. Optimizing the planning process is not done after a model has been established, and the integration and adoption of such often face hurdles and obstacles. Johansson et al. (2021) proposed in their research that 'perceived usefulness' and 'perceived ease of use' are factors influencing an individual's acceptance of technology, which is originally stated in the Technology Acceptance Model (TAM) by Davis (1989) [44] [22]. Sultan et al. (2023) used the TAM to research the social, environmental, and technological barriers to adopting last-mile logistics application [78]. Findings from research where another technology acceptance model was used, the Unified Theory of Acceptance and Use of Technology (UTAUT), on a maritime shipping industry case align with the TAM concept. Wiafe et al. (2019) show that the acceptance of a multi-carrier booking and shipping system in Ghana is influenced by factors such as performance expectancy, anxiety and attitude towards use on users [95]. Chua et al. (2023) have researched an industrial revolution in the maritime industry. Their research focused on the success factors of integrating sustainable shipping management, where knowledge management, technology acceptance and performance measurement are also critical factors for adoption [19].

Several studies have identified specific implementation barriers to integrating technology tools in the maritime industry. However, these studies all focus on integrating disruptive technology, a blockchain network. The impact and risk of integrating a blockchain network into the maritime industry are incomparable to those of integrating a planning system at just one company operating in the maritime sector. Balci and Surucu-Balci (2021) address three barriers that can be considered the root causes of the non-adoption of a blockchain network in a maritime supply chain [9]. Gausdal et al. (2018) have also found technical barriers to implementing a blockchain network [34]. Papathanasiou et al. (2020), Munir et al. (2022) and Chouhan et al. (2012) are adding more non-technical barriers to this list [68] [63] [17].

1.3. Knowledge gap and Research questions

From the literature review, it can be stated that an algorithm can optimize the planning of the empty container flow. However, it can also be noted that such an automated planning system has not yet been implemented, and technology acceptance factors might hinder its adoption. The implementation of blockchain can not be compared to implementing a planning system. As a result, the identified adoption criteria cannot be adopted either, which results in a fundamental knowledge gap. To close this knowledge gap, this paper aims to investigate barriers arising during implementing and adopting a planning system optimizing the empty container flow. The following research question will be central to this thesis:

"What are the adoption barriers and enablers for implementing an automated planning system in the planning of the empty container flow at a liner shipping company?"

To arrive at a substantiated answer to the main research question, it is first necessary to answer several sub-questions.

- *SQ1: "How can the integration of an automated planning system optimize the empty container repositioning flow?"* To understand how a planning system can optimize the empty container repositioning flow, it is important to first understand the workflow of this process without the system being implemented. This workflow can be used as a starting point when researching how a planning system can optimize this process. Researching these two workflows will be done via the first sub-question.

- *SQ2: "What system characteristics of an automated planning system can influence the adoption of such?"* From the reviewed literature, it became clear that the Technology Acceptance Model can be used to research adopting a new technology. However, it also became clear that this model has not yet been applied to similar technologies or fields of interest. As a result, this sub-question will identify system characteristics relevant to include in the TAM for the problem central to this study. Answering this question will result in a conceptual framework of the TAM that can be applied to adopting the automated planning system.
- *SQ3: "What barriers do planners of empty containers have to implementing and adopting an automated planning system?"* The framework established in the second sub-question will be used to answer this sub-question. Research will be done on which of the identified system characteristics is mainly influencing the adoption and what the perspectives against these system characteristics are to the system central.
- *SQ4: "What is needed to overcome the implementation and adoption barriers to improve the adoption rate of an automated planning system?"* This last sub-question will focus on what is needed to overcome the adoption barriers identified in the previous sub-question.

1.4. Research approach

The identified knowledge gap in the previous chapter results in a qualitative character for this research. Qualitative research is a useful tool, as it allows for the in-depth examination of subjects. Rather than relying on numerical data, qualitative research allows studying what associations occur in people's thinking or acting and the meaning these have for people [71]. A qualitative analysis will be performed based on an exploratory research approach. The exploratory approach is suitable for this research since it tends to tackle new problems on which little to no previous research has been done [13]. As shown in the literature review, no research has been done focusing on implementing and adopting a new planning tool within a company operating in the maritime industry. Since this industry will be the main focus of this research, an exploratory approach combined with a case study approach will be used, which can be seen as an exploratory case study approach. A case study research is conducted when the focus is needed on describing, understanding, predicting and/or controlling an individual [96]. To answer this research question, a focus is needed on an individual entity, a liner shipping company. Using an exploratory approach to a case study makes it possible to interview experts and stakeholders directly involved in the problem. This way of data gathering will ensure an in-depth and direct understanding of the problem. A typical- or representative case will be used for the case study to provide insights into a broader perspective of implementing and adopting a technology tool in a maritime company. A typical case exemplifies a typical set of values for a maritime company, not too specific, which can only be projected onto one company [36]. By using a typical case for a case study, it can also serve an exploratory role [36].

Due to time limitations of this research project, not all the needed information can be gained by conducting interviews. That is why a quantitative analysis will also be part of the research approaches used. Using quantitative analysis, it is possible to collect data from current users and potential users of the automated planning system by sending out an online questionnaire [32]. Since this is mainly done to save time, the overall approach of this research remains qualitative.

A disadvantage of the qualitative approach is that it can be a time-consuming process [5]. This limitation is reduced by having the researcher of this study directly involved at the company Maersk. As a result, there is daily and direct contact with needed respondents. Yin (2009) states that the lack of rigour can be the greatest limitation of case study research; too many times, the researcher has not allowed equivocal evidence or biased views to influence the direction of the findings and conclusions [100]. This possible pitfall is reduced by having a structured plan in advance of how and what data to gather from the stakeholders and company, which is checked by the supervisors of this study before execution. Furthermore, there is spoken with more than one representative of each involved department to validate responses.

1.4.1. Case selection

The research subject selected for this case study will focus on implementing an automated planning system at the globally operating shipping company Maersk. From introductory interviews to understand the company's operations, it became clear that Maersk has a lot of operating costs dedicated to the shipment of empty containers, which align with those mentioned in the introduction. Furthermore, the company has the operational characteristics of a global shipping company, focusing on market shares and cost reduction through ultra-large vessels and horizontal integration [94]. With 740 ships calling at 343 ports and terminals in 121 countries, Maersk has established a global container network, making it the second biggest shipping company in the world [56]. The horizontal integration is created with the acquisition of Nedlloyd and Hamburg Sud over the last couple of years and the recent announcement of the collaboration with Hapag-Lloyd [55]. All these characteristics make Maersk a suitable company to serve as a typical case.

The interview participants will be selected in collaboration with the company's supervisor. He has extensive experience and contacts within the company, having worked in different departments. During the research, it will become clear which departments and related participants are relevant. Because the researcher of this thesis is directly working from the company's office in Rotterdam, it is expected that contacting participants will not take too much effort. More than one participant in the involved department will be interviewed to validate responses. Interviews will be held in real life or via Teams. The relevant managers will be contacted to reach the target group of the survey. The survey will be conducted via Google Forms.

1.5. Research methods

Three research methods are used to answer the main research question. A combination of methods allows one to gain a proper understanding of the problem and make supported recommendations. The methodologies are presented in a sequential order in this section, however, they will be used in an interchanged and repetitive manner throughout the research process. The first method of gathering information is 'direct observations'. This is a distinctive feature of a case study and is found suitable since the researcher is a direct team member of the planning department of Maersk in Rotterdam [99]. The goal of gathering data via this method is to be as neutral and factual as possible. To gain more in-depth insights, interviews will be used as the second method. Conducting interviews will allow to gain insights in perspectives that are not directly observable. This information is needed to have a full understanding of adopting a new technology in the empty container repositioning flow. A literature review will be conducted on the TAM to establish a theoretical framework. This framework will be used in the final method used in this research, a survey. A survey will be sent out globally to gather data on the factors influencing the adoption of a planning system. Results from this survey will be analyzed in Excel and with follow-up interviews with participants.

1.6. Research structure

The objective of this study is to find the adoption barriers and enablers for the implementation of an automated planning system. Finding these barriers and enablers will be done via sub-questions, which will be answered in different chapters of this study.

Sub-question 1 will be answered in Chapter 2. In this chapter, the operations of Maersk, specified on the repositioning of empty containers, will be elaborated. Once this is clear, this chapter will delve deeper into the working of an automated planning system and its implementation in the workflow of planners. Together with an outline of the operations, this will form a coherent problem description of the problem central to this research. Chapter 3 will establish a theoretical framework by conducting a literature review on the working and applications of the TAM. This will answer the second sub-question and form the basis of the third sub-question. The theoretical framework from Chapter 3 will be used to answer sub-question 4 in Chapter 4. A survey will be conducted based on the theoretical framework. The survey results will be analyzed from which adoption barriers can be identified. This chapter will also answer the last sub-question. Researching users' needs to overcome the identified barriers will result in recommendations which answer sub-question 4. Chapter 5 contains the discussion and limitations of this study. The discussion is a reflection on the research and its results. The limitations also include recommendations for further research. This research will end with Chapter 6 in which an answer to the main research question will be formulated.

2
Problem description

This chapter will introduce the case study and related problems central to this research. First, the problem's owner will be introduced. Next, the process of repositioning empty containers is explained in more detail before looking at how the integration of a planning system can optimize this process and the current state of integration. This chapter will conclude with an answer to sub-question 1.

2.1. Operations Maersk

The problem owner central in this research is the international operating shipping company Maersk. Maersk is one of the world's largest shipping companies and each year responsible for shipping 12 million containers globally, which is 18% of the total volume of containers being shipped, and is operating in 121 countries [56] [16]. To provide this service, the company employs more than 100,000 individuals, each responsible for their part in the global supply chain, and deploys more than 700 container vessels [54].

2.1.1. Global empty repositioning

Due to global trade imbalances, Maersk moves 1 million empty containers monthly, a process further referred to as the repositioning of 'equipment'. The global trade imbalances result from the mismatch between the export of full containers with goods to be sold and the import of empty containers to be loaded again. Maersk is globally repositioning equipment to meet the shipping demand for its customers at the right time and place. The first step in this process is creating a Rolling Forecast (RoFo), where commercial trade flows and imbalances of containers become visible to the company. With this forecast, the "Center Management Team", located at the company's headquarters in Copenhagen, can review Maersk's current equipment fleet and transportation network to check whether it is sufficient to meet the demand of the RoFo. When both are found to be sufficient, local commercial teams break down the global forecast of the RoFo to a forecast of equipment needed for their responsible region. This first breakdown is still done on a high-level overview, only stating the amount and type of equipment required by the entire responsible region. It should be noted that the term "region" can be used to describe a vast area, such as the entirety of Northern Europe. Following this high-level forecast, a more detailed forecast can be made to plan the actual repositioning of equipment. Figure 2.1 represents the information flow of the needed equipment. This is presented via an IDEF0 diagram; arrows coming in and out of a box show the in- and output of the presented activity, which can be used as the direct input in the following activity. Arrows flowing in on top of a box show the control elements, and arrows flowing into the bottom show the supporting elements of the presented activity.

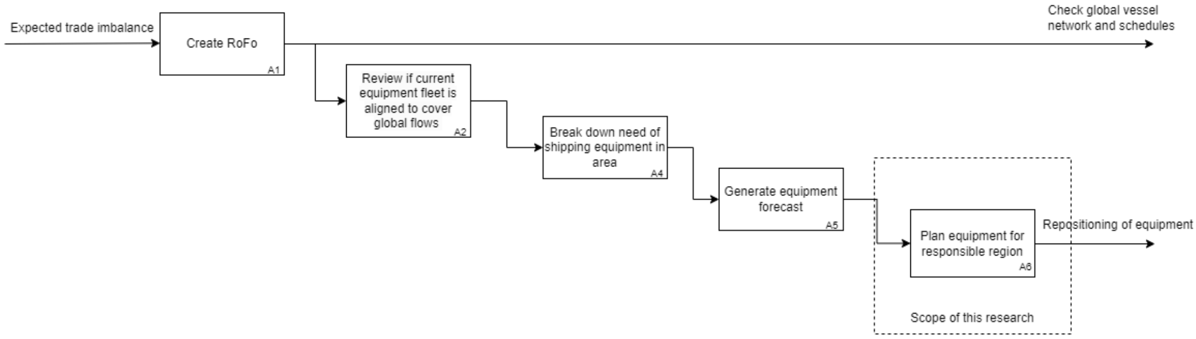

Figure 2.1: Global repositioning

This research primarily focuses on creating a repositioning plan for the equipment, the final step before actual repositioning. To get a better overview of how these repositioning plans are created, a more detailed process will be provided by zooming in on this activity in the next section.

2.1.2. Creation of repositioning plan

A detailed graphic overview of the planning flow can be seen in Figure 2.2. Equipment planning begins with a machine learning model for global demand and return forecast, which is amended by local commercial teams. This forecast is further broken down by the equipment planners, referred to as Equipment Flow Analysts and Equipment Operators. This detailed execution plan will be more geographical, zooming in on different *sites* and *pools* operated and/or used by Maersk from which equipment can be re-positioned. A site is a location where equipment can be imported, exported, and stored. It is closed off by fences to mark the end of a site. Planning repositioning moves on site level is the most in-depth level Maersk plans on. A pool is a cluster of multiple sites, which don't have to be located right next to each other to be included in the same pool. For example, the APM2 terminal at the Maasvlakte and the Waalhaven terminal in the Botlek are grouped in the same pool. Furthermore, this forecast is also broken down into different types of equipment. Since this research focuses on creating repositioning plans in general, the different types of equipment are not included in the scope.

Everything related to the planning and execution of equipment is done on the online platform *ROCK*, created and operated by Maersk. Following the final import and export forecast, the Equipment Operator sets a Target Stock Level (TSL) in ROCK. The target stock aims to create an optimal use of the assets by having enough supply to cover the demand but not having too much to reduce utilization and high storage costs. The TSL and the forecast will allow ROCK to calculate the optimal equipment stock range on both pool and site levels. A TSL is based on three parameters suggested by ROCK based on historical data but can also be manually altered by an Operator. These parameters are:

- Amount of days needed to check and prepare equipment
- Amount of days of delayed supply that needs to be covered
- Trade imbalance days an Operator wants to have of extra supply

To meet the optimal equipment stock, equipment is planned for repositioning via an Order To Transport (OTT). The Flow Analyst and the Operator create an OTT for their respective regions. To create this plan, there is a continuous communication stream between the Equipment Flow Analysts, the Equipment Operators, and other operational and commercial departments. When each department agrees on the supply and demand volumes, equipment can be planned for transport. In 2022, 28.500 repositioning orders by vessel were created by Equipment Flow Analysts and Equipment Operators; this excluded OTTs by barge or truck.

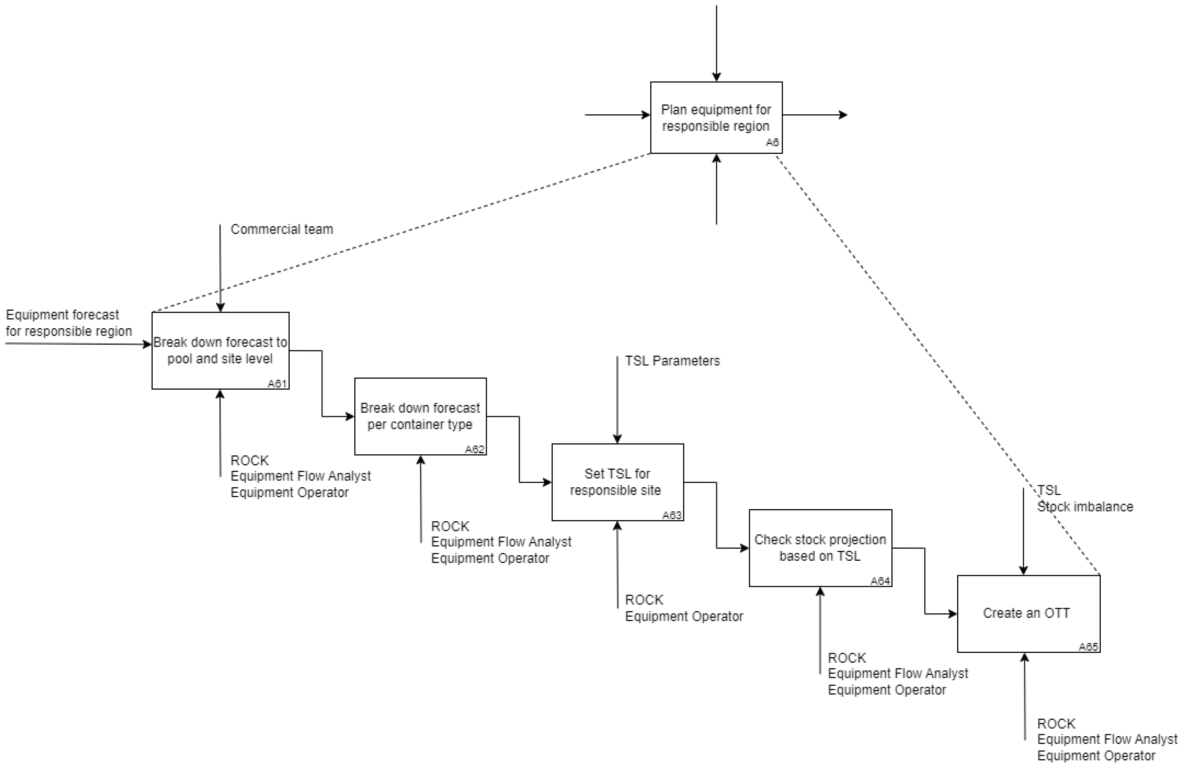

Figure 2.2: Current repositioning

Reviewing this workflow reveals two significant findings. The first is the parallel and individual activities of the different equipment planners, each working on their own responsibility and scope and together on the repositioning of equipment in general for the region. Another interesting aspect to zoom in on is the formulation of the TSL. This is an important factor in setting up the equipment planning as it is the main driver for creating an OTT, next to the import and export forecast. However, in the current workflow, this is only based on three parameters and a lot of experience from the Equipment Operator.

2.2. Equipment planners

As it became clear from zooming into equipment planning, two types of Maersk employees can be distinguished as being responsible for the planning and executing equipment operated by Maersk: the Equipment Flow Analyst and the Equipment Operators. This comprises approximately 230 employees spread across 5 operational regions globally.

Responsibilities

The Equipment Flow Analysts are responsible for planning equipment between ports, transported by container vessels sailing on a fixed rotation. Each Flow Analyst has a specific scope of pools for which they are directly responsible. Equipment Operators are responsible for planning equipment between sites, being container depots and terminals, which can be transported via barge and rail or truck to inland depots. Like the Flow Analysts, each Operator has a specific scope of sites for which they are individually responsible.

Even though the responsibilities of these groups seem similar, it is important to highlight the main difference, which becomes visible by the responsible scope. Flow Analysts only plan equipment repositioning between terminal locations where deep-sea vessels berth, resulting in repositioning moves with much larger numbers of containers than repositioning moves created by Operators. Repositioning moves between depots or smaller inland terminals are not in the same order of magnitude. Next to this difference, it is also important to highlight the cooperation between these teams. The Equipment Flow Analysts use the number of containers that Equipment Operators additionally have available after covering their demand as input for creating equipment repositioning on a pool level. Figure 2.3 presents a simplified overview of the planning responsibilities of equipment planners in The Netherlands.

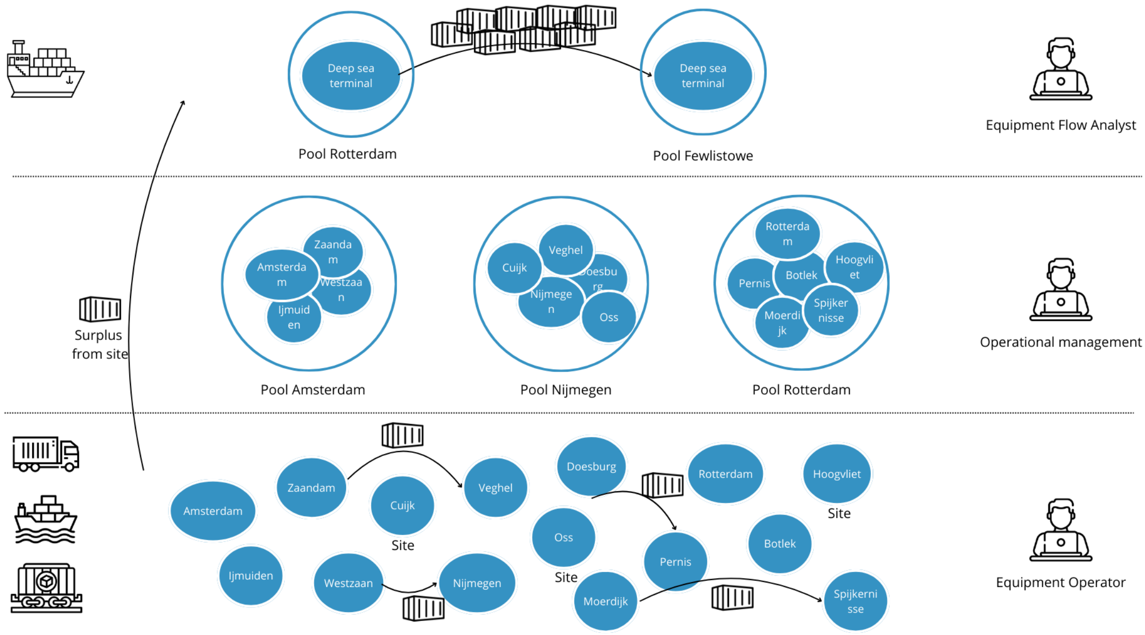

Figure 2.3: Operational planning levels

Targets

Operators and Flow Analysts have the same target when creating repositioning plans: the optimal distribution of available equipment for their responsible scope. This is measured against the stock factor, defined as the total equipment stock level divided by the export of equipment at the discussed location within the scope of the responsible Operator or Flow Analyst (Appendix D.1). The equipment planning becomes more inefficient as the stock level increases. However, low stock levels are undesirable either, as this has other implications. An optimal stock level must be determined for each location, as each location has different characteristics. The TSLs are set on site level by an Operator as elaborated on in subsection 2.1.2. This TSL is further reviewed by operational departments, first on pool level, before moving to a high-level regional overview. The company headquarters in Copenhagen also reviews and checks these targets. Their comments need to be translated back in the operational chain all the way to the original TSL on site level.

Next to the stock factors, the Flow Analysts are also measured against the utilization of the container vessels they are using in their repositioning flow (Appendix D.1).

2.3. Optimizing operations

To reduce costs and the total amount of equipment needed to cover the demand of all bookings, Maersk developed an automated planning system. Furthermore, it was designed to shift manual efforts of creating equipment planning to automated and more scalable planning. The initial idea for developing this system was a strategic initiative from the management layer of the company. Before the company developed their own equipment planning platform, initiatives on automation were taken in collaboration with IBM. Together, a platform was developed which was globally used by Equipment Flow Analysts. Around 2015 and 2016, this collaboration was discontinued, and a company-owned platform was developed, resulting in ROCK. The integration of an automated equipment planning system started at the end of 2017 and was finalized in October 2018 with the development of the optimisation algorithm 'Pool-Level-Planning' system (PLP) (Appendix D.4).

This optimiser solves a multi-commodity flow problem with extra constraints added to the problem. It is integrated into ROCK and suggests an OTT to a Flow Analyst or Operator that minimises operational costs, satisfies customer demands and adheres to operational constraints. When suggesting an OTT, the system considers a total of 23 criteria and constraints, as shown in level A65 in Figure 2.4. This is more than is humanly possible to consider when manually creating an OTT. The responsible team imports all the input data PLP needs from departments other than equipment planning into ROCK. Input needed from the equipment planners can be adjusted by constraints in ROCK. Since there initially was not much faith in this type of available data, developers of the system wanted to give users of PLP the option to overwrite the data when more information was available (Appendix D.9.2). This can be done by adjusting the constraints on multiple screens in ROCK. Since these values can change over time, updating the constraints can be done unlimited times. The responsibility of setting these constraints correctly lies with the Flow Analysts and Operators since they are expected to know the correct values. When all input data is correctly set and updated in ROCK, the algorithm will use a mathematical model to calculate the optimal repositioning schedule each night, resulting in OTTs suggested by PLP. The system is designed to create OTTs loading eight weeks ahead and creates repositioning plans on the pool level. However, since a pool is a cluster of sites and not an actual location, the PLP system will automatically allocate the OTTs between sites where a deep-sea vessel can berth based on the vessel schedule. For inland repositioning, the system uses historical data. This site can be manually changed by the Operator when not correct. The implementation of the PLP system in the workflow of a Flow Analyst and Operator can be seen in Figure 2.4. Not many changes occur when comparing this workflow with the workflow without the PLP integration, as shown in Figure 2.2. A clear distinction can be made between the input criteria and constraints PLP needs compared with only the TSL when forming an OTT. Furthermore, it is important to highlight that the PLP system is not designed to replace employees with a computer system (Appendix D.8). As described in this paragraph, the system will always need the correct input data from the equipment planners to optimize the equipment planning, which is data that can not be automated. The operations done by the planners will change since they won't have to create an OTT themselves but analyze a suggested OTT. Furthermore, it is expected that the role of users of the PLP system will shift from planning equipment to analyzing the optimal set of constraints.

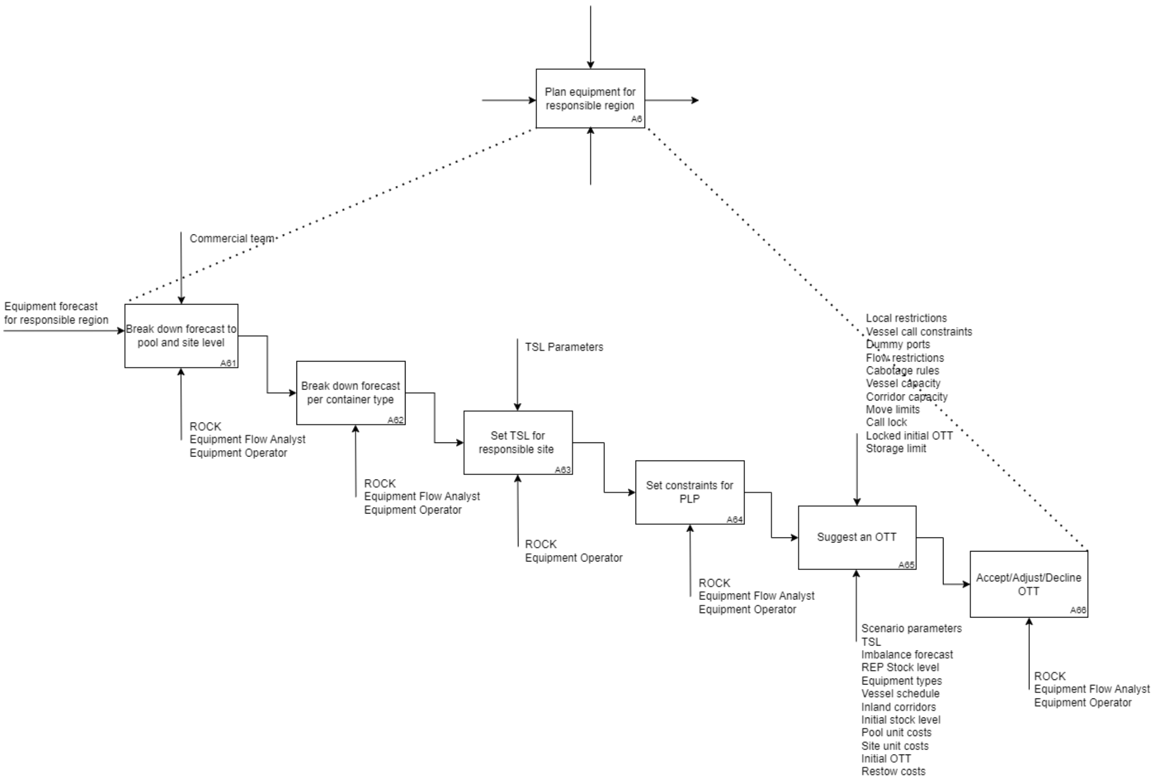

Figure 2.4: Integration of PLP system in workflow

To optimally roll out this implementation, equipment representatives from different operational regions were invited to a multiple-day workshop where the system was explained, and training material was handed out. These representatives were the point of contact for implementing the system in their respective regions. Employees from both the management and development teams, as well as current users and non-users of the system, are confident that, at that time, enough information and efforts were given for the full and proper adoption of the system. People were dedicated to using the new way of planning equipment, and a big effort was put into transforming the workflow. The region Europe was leading in this adoption as they already had more standardized processes than other regions (Appendix D).

While the new system was initially adopted, the COVID-19 pandemic hit the maritime sector. During this pandemic, the entire shipping industry was in disorder, and little to no attention was given to the use of suggested OTTs by the PLP system. It was not until mid-2023 that new attention was given to using an automated equipment planning tool.

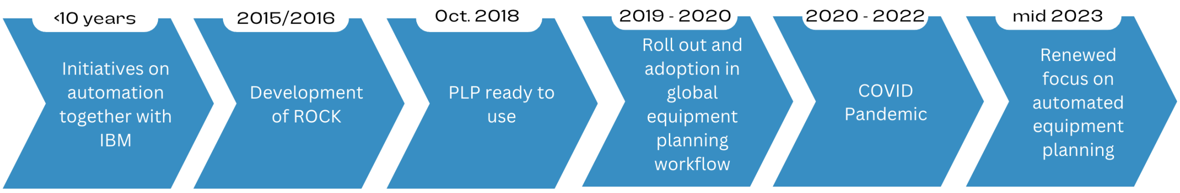

Figure 2.5: Timeline of development

2.4. Current adoption of PLP system

Since the company has paid more attention to using the PLP system, it is becoming clear that the pre-COVID implementation was unsuccessful. From direct observations at Maersk's Rotterdam office and interviews with employees, it is becoming clear that not everyone involved in the operational planning of equipment is using the PLP system to do so. The Equipment Operators are most negatively against adopting the new system in their workflow. Currently, this group experiences more hindrance and annoyance from the system's suggestion than potential benefits (Appendix D.5 D.6 D.7). In contrast, the Equipment Flow Analysts are positive about implementing the optimiser in their workflow; globally, they all use the suggestions of PLP when planning repositioning equipment moves (Appendix D.2 D.3). Restrictions are set to optimise the planning, and even though correctly setting these can be challenging, the system saves them time when creating a repositioning plan. The system also encourages them to think about new equipment delivery plans they did not think about before, which these users experience as a positive effect of the system they were not expecting.

For the strategic level of the company, it is also clear that the implementation and adoption of the system failed. They state that there appears to be a mismatch between the developed system and the operational work the system should be able to optimize since not every equipment planner has adopted the system (Appendix D.4). They do stress that this is neither the fault of the developer nor the system user. Nevertheless, this also makes it challenging to identify the root cause of the slow adoption rate and develop an effective solution.

2.5. Takeaways Chapter 2

The analyses done in this chapter answers the first sub-question.

SQ1: "How can the integration of an automated planning system optimize the empty container repositioning flow?"

Analyzing the global repositioning process, it became clear that the repositioning of empty containers starts with global trade imbalances. This imbalance is reviewed by different operational and commercial teams on different levels before actual repositioning happens. This thesis focuses on the creation of repositioning plans on an operational level. Equipment Flow Analysts and Equipment Operators are responsible for creating these plans at pool and site levels. Both the equipment planners use the TSL and their own experience when creating a repositioning move, an OTT. Optimizing the creation of these repositioning plans can be done by implementing a system based on an optimizing algorithm. Maersk has developed such an automated planning system called the PLP system. The PLP system considers more input when creating an OTT than is humanly possible. This input is imported into ROCK by the responsible departments and set by constraints by the Flow Analysts and Operators.

The recent focus on the PLP system, introduced before the COVID-19 pandemic, has revealed that the implementation process was unsuccessful, as not all Operators are using the system. However, it is not clear to Maersk what is causing the system's lagging adoption.

3
Conceptual model

The takeaway from the problem definition chapter demonstrated that the root cause of the low adoption rate of the new system is not yet clear to the company. To define this cause, the Technology Acceptance Model (TAM) by Davis will be used [23]. This model provides a theoretical framework that can be used to identify the underlying causes of the system's acceptance issues by Maersk's equipment planners. Researchers suggest that the TAM is robust across time, settings, populations, and technologies and has received empirical support through validations, applications and replications [89].

The original TAM is over 30 years old, and much technological development has happened since. To create a framework that applies to a modern technology tool, the researcher of the current thesis is also interested in applications and possible extensions of the TAM. To ensure an accurate and comprehensive framework is established, a literature review will be conducted on the TAM by Davis and the model's applications to technology acceptance problems. Reviewing the applications will establish a specific extension of the original TAM. This will be used to identify the cause of the lagging adoption of the PLP system.

3.1. Technology Acceptance Model

The acceptance of new technologies has been a research topic for many years. Several researches have been conducted on the individual, organizational and technological variables influencing the acceptance of new technologies; however, key determinants for the acceptance were missing [33][11]. That is why Davis (1989) pursued to find measures for predicting and explaining the acceptance of new technologies, which resulted in the development of the Technology Acceptance Model [23]. The TAM is adopted from another, more general, psychology-based theory, the Theory of Reasonable Action (TRA) [24]. The TRA is designed to explain human behaviour generally and can be applied to computer usage. Davis used the basis of the TRA to design a model to explain the specific behaviour of humans concerning computer usage [25]. Davis causal links two key beliefs that determine the behavioural intention of someone to use a new technology, which in turn influences users' attitudes and intentions toward actual system use. The two key beliefs are *Perceived Ease of Use* and *Perceived Usefulness*. Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" [23]. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" [23]. The experienced usefulness a user has of a system is directly influenced by the experienced ease of use of the new technology. Both of these beliefs directly influence a user's attitude towards using the technology, which, according to the TAM, is the only factor influencing the actual use and adoption of a new technology. The final adjustment of the TAM by Davis came from the hypothesis that the two beliefs were directly influenced by the *system design characteristics*, in Figure 3.1 presented by the boxes X1, X2 and X3 [23]. The direct influence of these characteristics on the two major beliefs of the TAM and, consequently, the system's actual use allows for identifying the most important characteristic in users' adoption of the system. Determining these system characteristics has been the subject of extensive research and will be further explored in the next section.

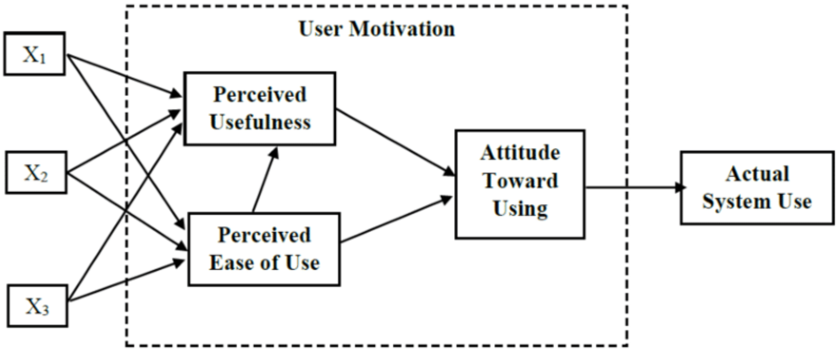

Figure 3.1: Technology Acceptance Model [23]

3.1.1. Use of TAM

TAM is one of the most widely cited models in the field of technology acceptance [97]. With every model, especially models related to a constantly developing industry such as technology, extensions and adjustments are happening over time, resulting in new system characteristics for the acceptance of technology. In 2015, Marangunic and Granic conducted a literature review of 85 scientific articles published between 1986 and 2013. These articles have been grouped into three categories: (1) TAM literature review, (2) Development and Extension of TAM and (3) Modification and Application of TAM [58]. The researcher of the current research is mostly interested in determining system characteristics that influence the adoption of a new system. After analyzing the literature review globally, it became clear that the determination of the characteristics could most likely be found in the category 'Development and Extension of TAM'. Reviewing 32 articles in this category revealed that those related to the extension of the TAM were most informative in determining system characteristics. 20 articles related to this topic and their field of interest are listed in Appendix B.1.

Since this literature review only included articles until 2013, an additional search on the search engine 'Scopus' was conducted to retrieve articles published after 2013. For this, the search string, *TAM AND "Technology Acceptance Model" AND extension"* with an applied filter of the year of publication between 2014 and 2023, was tested first to see the number of articles related to this topic, which resulted in 203 documents. The addition 'extension' to this search string was chosen in line with the sub-group in which relevant articles were found in the previous literature review. Due to time limitations, it was not possible to properly review all these articles. As some previously selected articles did not address system characteristics but rather determinants, it was chosen to add *AND determinant* to the search string and apply more filters only articles in the final publication stage, and only in English, which resulted in 28 articles. These articles were selected to conduct a small literature review, in which the field of interest of the articles was reviewed. These articles and fields of interest can be found in Appendix B.2.

After analyzing the fields of interest of the selected articles from the two literature reviews, it becomes clear that they can not be compared to the maritime sector, container repositioning or logistics in general. Most articles focus on different sectors and/or the acceptance of a very different technology. That is why the system characteristics resulting from these articles are not suitable for use for the acceptance of the optimizer for equipment repositioning. Two articles are not included in this exclusion since these do not focus on a specific field of interest or technology. The first article results in the model by Venkatesh (2000), which focuses on a broad field of interest and results in determinants specifically focused on the perceived ease of use [89]. In the same year, Venkatesh and Davis also created a model focusing on determinants influencing perceived usefulness, referred to as the TAM2 [91]. The potential Inclusion of system characteristics derived from these models in the framework to be applied to the PLP adoption will be further investigated in the next section. This section will select system characteristics relevant to the adoption problem central to this study.

A series of four requirements, on which the system characteristics are tested, has been established.

The models selected from the literature review date from more than 20 years ago; it might be that not all system requirements identified back then are relevant to current technologies. Therefore, the first requirement for selecting system characteristics is its relevance to the technology of the automated planning system. Furthermore, the system characteristics should not be too focused on a particular direction or technology since the adoption barrier's cause is not yet known in this research stage. The use of technology central to this study is not visible to society, only to employees of Maersk, therefore, system characteristics that relate to the visibility to others will not be relevant. The last requirement relates to the possible overlapping meaning of system characteristics when selecting them from multiple models. When this is the case, only one relevant system characteristic will be selected.

3.2. System characteristics TAM

3.2.1. Perceived Ease of Use

Venkatesh (2000) developed a model specifically defining the determinants of perceived ease of use [89]. In this model, he built on the anchoring and adjustment framing of human decision-making. This framework suggests that individuals rely on general information that serves as an 'anchor' in the absence of specific knowledge about a system. The influence of these anchors is so strong that individuals often do not realise the framing is happening. When additional information about a system becomes available, individuals tend to adjust their first perceptions [89]. The anchors suggested as determinants for perceived ease of use are computer self-efficacy, computer anxiety, and computer playfulness, which can be defined as individual and perceptions of external control. The last anchor influencing perceived ease of use is perception of external control. The belief of perceived ease of use can be adjusted over time when experience with the system is gained. This is done by the two adjustment determinants: perceived enjoyment and objective usability. However, research has shown that these adjustment determinants are not always strong enough to change the initial view of the system formed by the anchors. A graphical representation of this model is shown in Figure 3.2, and definitions of the determinants can be found in Appendix C.1.

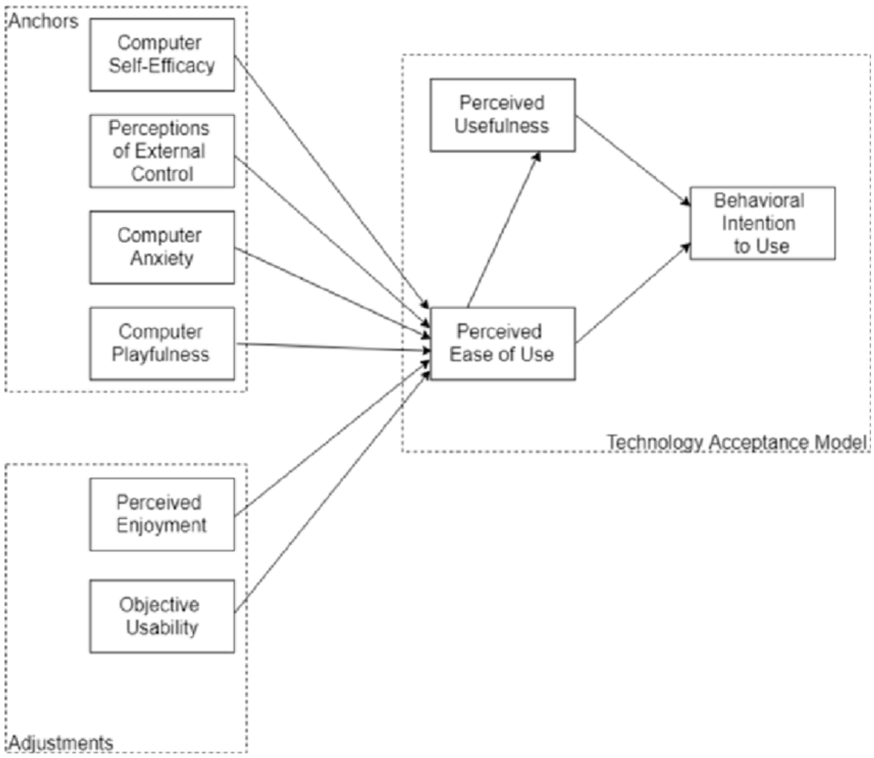

Figure 3.2: Determinants Perceived Ease of Use

3.2.2. TAM2

Another extension to TAM by Davis is also done in 2000 when Venkatesh, together with Davis, researched additional key determinants to the belief *perceived usefulness* and usage intention determinants together with the understanding of the effect of increasing experience with the system [91]. This resulted in additional determinants which can be grouped into 'social influence processes' and 'cognitive instrumental processes', both accountable for the underlying judgements of perceived usefulness. A graphical representation of the TAM2 is shown in Figure 3.3, and an overview with the definitions of the additional constructs can be found in Appendix C.1. All arrows shown represent a positive effect on the determinant, from which the arrow is leaving, on the belief to which the arrow is pointing. Two exceptions are: 'Voluntariness' will moderate the effect of 'Subjective norm' on the intention to use the system by an individual, and increased 'Experience' will attenuate the direct effect of 'Subjective norm' on perceived usefulness and intention to use.

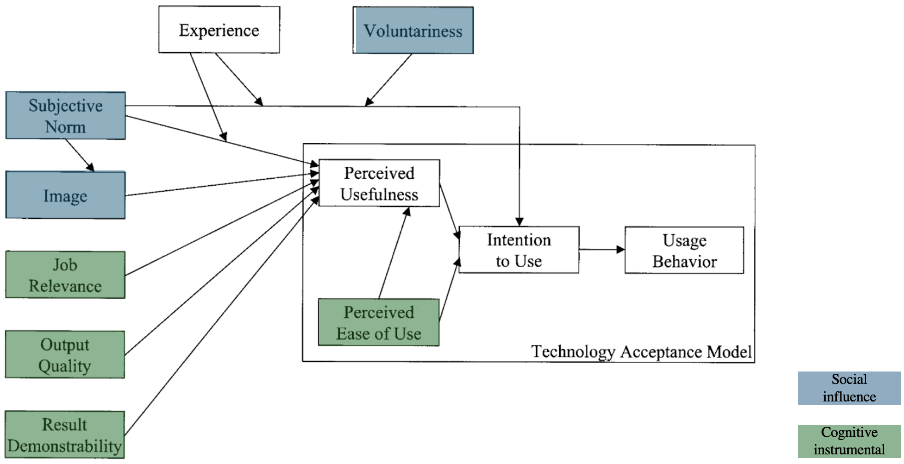

Figure 3.3: TAM2

3.3. Additional frameworks on technology acceptance

Next to the TAM, two other models are commonly used when researching the acceptance of technology, the *Diffusion of Innovations Theory* (DOI) by Rogers and the *Unified Theory of Acceptance and Use of Technology* (UTAUT) by Venkatesh et al. [74] [87] [79]. These models both have interesting determinants to combine with the determinants from the selected models in subsections 3.2.1 and 3.2.2 when identifying the acceptance of the PLP system. The DOI can be compared with the TAM since both solely focus on the beliefs about a technology. Determinants from DOI are interesting to include because of their use on organizational and individual levels and on a global level; since the equipment planners of Maersk are globally distributed, this is interesting to consider [79]. The UTAUT model is interesting to include since this is taking moderating variables into account that were not yet included in both the original TAM and the system characteristics of Perceived Ease of Use and Perceived Usefulness [79]. A graphical representation of these models is shown in the figures below. Definitions of the determinants of both models can be found in Appendix C.1.

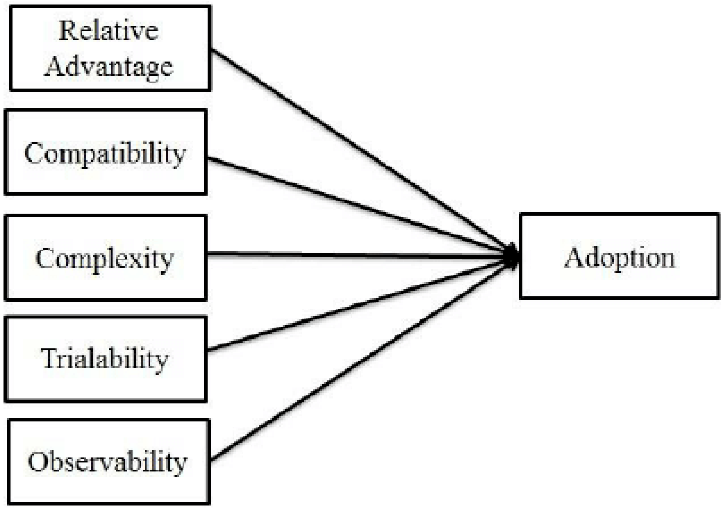

Figure 3.4: Diffusion of Innovation theory [74]

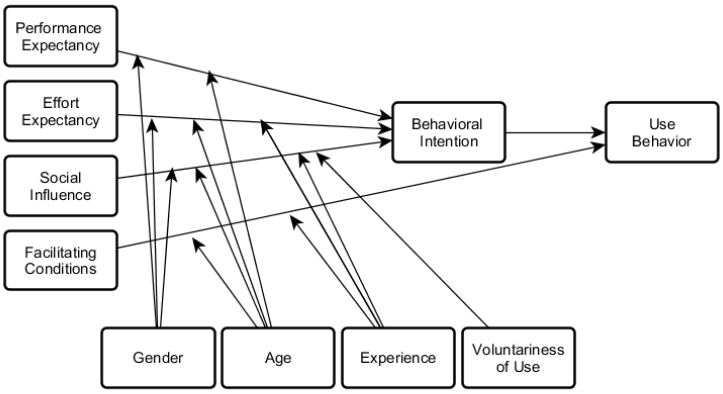

Figure 3.5: Unified Theory of Acceptance and Use of Technology [87]

3.4. Final model

As mentioned in section 3.1, Davis stated the hypothesis that system characteristics influence the TAM's two beliefs. However, these had not been identified yet, which resulted in the subject of much research in the years that followed. This is also the case in the current study. Central in this research is the identification of the system characteristic of the automated planning system that is preventing adoption by the equipment planners. Since no research has yet been done on the identification of suitable system characteristics influencing the TAM with a focus on the maritime sector, a conceptual model is developed by the researcher of this study. This model focuses on extending the TAM by Davis, by selecting suitable system characteristics that are expected to influence the TAM's beliefs for this specific adoption. The model is established after the evaluation of the system characteristics in the previously selected models in this chapter.

It is decided not to include all system characteristics from the selected models in the final conceptual framework. By excluding determinants irrelevant to the technology central to this research, more focus can be given to exploring determinants expected to influence the system's acceptance. Furthermore, overlapping meanings of the system characteristics from the different models could be identified, making it irrelevant to include both. The final model is presented in Figure 3.6. The meaning of the system characteristics and the reason for including them in this model is stated in Table 3.1, reasons to exclude the other system characteristics can be found in Appendix C.2.

The model established in this section will facilitate a framework for conducting targeted research on the adoption barrier to new technology in the maritime sector. This barrier is expected to be in one or more of the selected system characteristics. The targeted research will be done via a survey for which the selected system characteristics form the basis.

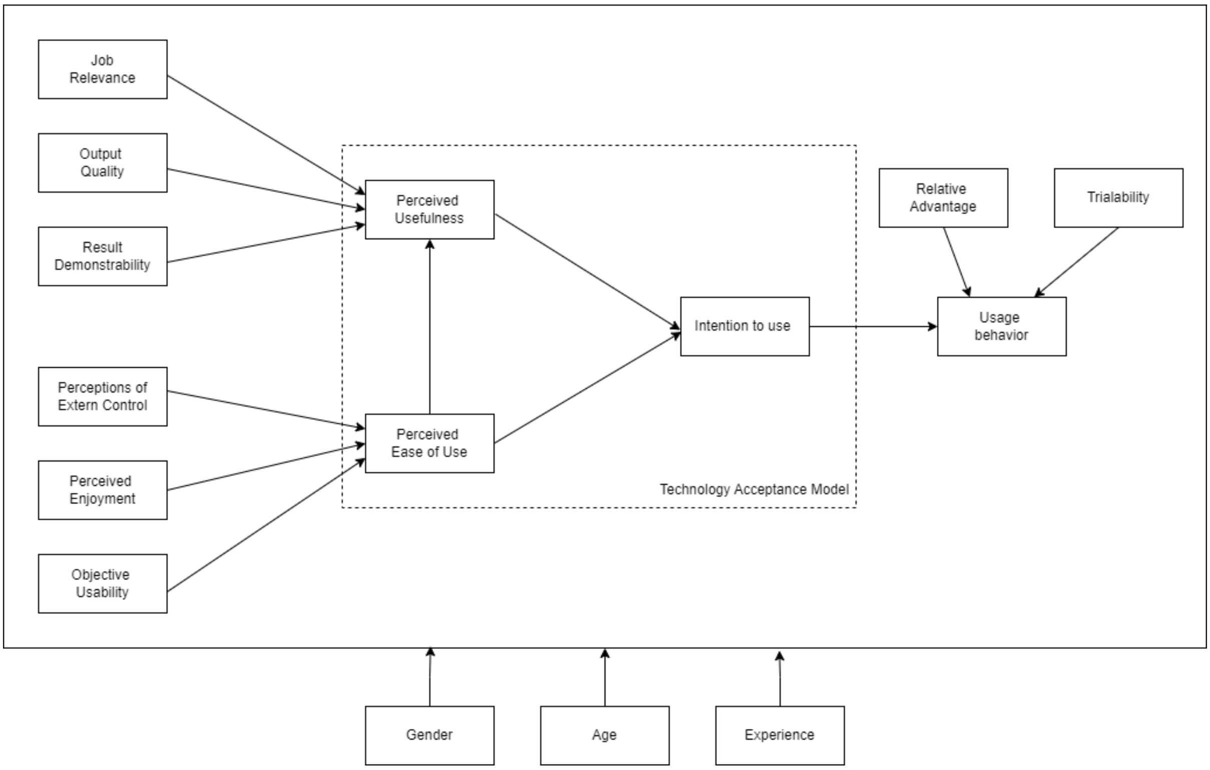

Figure 3.6: Final model used in this research

Table 3.1: Characteristics included in model

Characteristic	Definition	Reason for selecting
Job Relevance	The degree to which an individual believes that the target system applies to his or her job [90]	Implementation of technology will have an effect on the job of users
Output Quality	The degree to which an individual believes that the system performs his or her tasks well [90]	Implementation of technology will have an effect on the job of users
Result Demonstrability	The degree to which an individual believes that the results of using a system are tangible, observable, and communicable [90]	Implementation of technology will have an effect on the job of users
Perceptions of External Control	The degree to which an individual believes that organisational and technical resources exist to support the use of the system [90]	New function of the system for which support will be needed when implemented
Perceived Enjoyment	The extent to which the activity of using a specific system is perceived to be enjoyable in its own rights, aside from any performance consequences resulting from system use [90]	Can also measure the possible frustration against the implementation of the system, important to understand if there currently is any frustration

Continued on next page

Table 3.1 – continued from previous page

Characteristic	Definition	Reason for selecting
Objective Usability	A comparison of systems based on the actual level of effort required to complete specific tasks [90]	To measure what users think about the current usability of the system, if there is something that needs to change relating to this aspect
Relative Advantage	The degree to which an innovation is seen as better than the idea, program, or product it replaces [26]	To test whether users understand the usefulness of the development
Trialability	The extent to which the innovation can be tested or experimented with before a commitment to adopt is made [26]	To test whether users would like to test the system before implementation
Experience	Moderating effect when more experience with the system is gained	To test the influence of people who are already working with the system have worked with the system in the past, and people who have no experience with working with the system

3.5. Takeaways Chapter 3

This chapter has established a theoretical framework to identify the problem in the lagging adoption of the PLP system. This was done based on Davis's Technology Acceptance Model, the TAM. To identify the system characteristics that influence the two beliefs of the TAM, two generalised extensions of the TAM, TAM2 and Determinants Perceived Ease of Use, are chosen. To complete the literature review, determinants from other technology acceptance models, DOI and UTAUT, were also included in forming the final framework. The selection of these models makes it able to answer the second sub-question.

SQ2: "What system characteristics of an automated planning system can influence the adoption of such?"

After selecting eight system characteristics and four moderating variables from these models, a final framework was established. This theoretical framework will be used to identify the root cause of the PLP system's lagging adoption.

4

Acceptance of an automated planning system

Having established the context of the case and the framework to be employed in its examination, it is now possible to proceed to the subsequent phase of the study. This chapter will focus on identifying the adoption barriers against the automated planning system. Following these, it will be possible to draft enablers to improve the adoption rate of the system. This will answer both sub-questions three and four. Since these are related to each other, it is chosen to discuss and answer both of them in one chapter.

4.1. Use of conceptual model

The established model from the previous chapter (Figure 3.6), will be used to identify the root cause of the lagging adoption of the PLP system. The focus will be on the influence of the system characteristics on the adoption. A survey will be conducted, in which the system characteristics will be central. A survey is a useful tool for gathering the opinions of all equipment planners at once. According to equipment planners in a liner shipping company, the outcome of this survey will identify which system characteristics have the biggest influence on the adoption of a new technology system. Furthermore, the current perspectives on system characteristics in relation to the developed system will be clarified. Since a survey is not an appropriate method for obtaining detailed opinions and precise thoughts on the system characteristics, in-depth interviews will be conducted. It is chosen to conduct a survey prior to interviews to gather a large amount of data regarding the influence of the system characteristics, which gives a direction for in-depth research via interviews.

The results of both the survey and the interviews will be used to form recommendations for Maersk to improve the planning system's adoption rate.

4.2. Survey

The main target group of this questionnaire are the Equipment Flow Analysts and the Equipment Operators of the five global operational regions. However, since there are small differences in the workflow responsibilities per region, the questionnaire is made for everyone responsible for creating OTTs, also those responsible with another job title than mentioned.

The structure of the questionnaire can be divided into four segments. The first segment is related to the demographics of the participants. These questions focus on the age group, gender, operational region and years of experience at Maersk. Including these questions allows the possibility to reveal differences in the perspectives among different groups of participants. The next segment contains questions about the participants' knowledge of the PLP system. Since it became clear that not everyone has implemented the system in their workflow or had the same introduction to the system, it is important to know the participant's level of knowledge before reviewing their perspectives on using the system (Appendix D.2 D.3 D.5 D.6 D.7). A general introduction or recap will be given before the next two segments start.

This ensures that participants begin the final two sections with a baseline understanding of the topic. The third segment of the survey identifies the value users ascribe to the system characteristics in general, set out in the framework. The last segment researches users' perspectives on the PLP system based on the viewpoint of the characteristics.

Questions related to the demographics of the respondents are asked on a multiple-choice scale specifically designed for the related question. This is a suitable scale for these questions since they contain specific information. Questions focusing on the determinants of technology acceptance are asked on a 5-point Likert scale. This scale makes it possible to gather the type of data needed from the questionnaire, respondents' opinions and attitudes towards accepting the PLP system [20]. Since the researcher does not know the capabilities of this questionnaire's target group, the 5-point scale is preferred over the 7-point scale. The 7-point scale has the downside of possibly being too overwhelming and time-consuming [20]. To optimise the results retrieved from the questionnaire, the less complex 5-point scale is chosen.

4.3. Results

An initial email was sent to the local equipment managers to help the researcher of this study distribute the survey. The email included a short introduction about the purpose of the research and the specific survey. Furthermore, participants were also informed that no preparation was needed and that participation was completely anonymous. The managers forwarded the email to the designated employees or shared an email list of the equipment planners reporting to them.

The questionnaire was sent to approximately 230 potential respondents, and the period during which responses could be submitted was two weeks. After two weeks, no new participants were included in the survey, resulting in a total of 56 respondents for the final analysis. This represents 24% of the target group, sufficient for an online survey to continue the research [29]. Table 4.1 shows the response ratio per operational region. The communication problems between the researcher and the local managers can explain the relatively low response percentage from the regions APA and AMR. This resulted in the lack of access to the personal contact details of the target group or the email being forwarded by the manager. To still reach equipment planners working in these areas, large email lists containing people working in operations were used and not directly targeting equipment planners. The distinction between the individualised approach in EUR, AFR and IME and the collective approach in the other two regions is reflected in the response ratios. 16 respondents can be categorized as Equipment Flow Analysts, and 35 as Equipment Operators. As a result of local differences in job titles and responsibilities, 5 respondents have a job title that can not be captured in these two categories.

Google Forms automatically saved all the results in an Excel spreadsheet, enabling the retrieval of further in-depth results; no other statistical analysis programs were used.

Table 4.1: Response ratio

Region	Target group	Participants	
EUR	76	26	34%
AFR	13	5	38%
APA	64	7	11%
IME	14	7	50%
AMR	63	11	17%
Total	230	56	24%

4.3.1. Importance of characteristics

The first analysis of the results is done on the importance participants ascribe to the system characteristics. The results are divided into two groups: results categorized per region and results categorized by job title. These two groups have been chosen in line with the distinction the company makes; groups based on other demographics would not be useful for the company.

No discernable differences can be identified between the average scores of the five regions assigned to the importance of the characteristics (Table 4.2). All regions give a high average score to all the characteristics included in the model. The only 'outlier' has a score of 3,40 out of 5, which is the 'perceived usefulness' scored by the AFR region. However, this score can still be rated as high. The analysis of the results is done in Microsoft Excel; this program does not support testing for significance between all the regions, taking into account the different numbers of respondents. An ANOVA test would not be suitable since it is not able to capture all the characteristics of this data. However, to understand the potential significant differences between the results per region, a t-Test with unequal variances is performed on the results of two regions, where H0 states no significant differences between the regions. The regions EUR and AFR are selected for this test since they have the biggest difference in operations. The results show that H0 cannot be rejected, $t(14) = 0{,}34$; $p<0{,}05$. Since these regions have the biggest difference in operations, it is assumed that no significant differences between the other regions could be identified. Since the number of responses from some regions is small, analyzing the standard deviations of the regions provides no added value to the analyses.

Table 4.2: Importance of characteristics per region

System characteristic	**Average**				
	AFR	AMR	APA	EUR	IME
Output Quality	4.60	4.64	5.00	4.54	4.57
Trialability	4.40	4.64	4.86	4.42	4.29
Perceived ease of use	3.60	4.64	4.86	4.54	4.29
Relative advantage	4.40	4.55	4.86	4.58	4.14
Objective usability	4.40	4.55	4.86	4.46	4.14
Perceived usefulness	3.40	4.45	4.71	4.31	4.14
Result demonstrability	4.40	4.27	4.57	4.23	4.14
Job relevance	4.60	4.18	4.00	3.96	4.14
Perceived enjoyment	4.00	4.09	4.00	3.88	4.00
Perceptions of external control	3.80	4.09	4.14	4.23	3.71
***t*-Test**					
Mean AFR	4,16				
Mean EUR	4,32				
df	14				
t	0,34				

The survey's first part results, categorized by job title, demonstrate that the two types of planners tend to assign high scores to the importance of the characteristics when adopting a new system. As presented in Table 4.3, the average score of the characteristics is only below 4 out of 5 by just one of the characteristics. Analyzing the two groups' standard deviation reveals little differences regarding the importance of the characteristics. The only outlier is the characteristic 'job relevance' scored by the Equipment Operators. With a standard deviation of 1,12, it can be stated that, within this group, there are big differences in the view of the importance of this characteristic. An assumption for this outcome could be that respondents had latent thoughts when answering the question related to job relevance. The job relevance of the currently implemented planning system, instead of the job relevance of a new system in general. Based on analyzing the high average scores and low standard deviations, it can be stated that both equipment planner types consider all system characteristics as important. With the scores of both types of equipment planners being very close to each other, the significant difference between the two groups is tested. A t-Test with unequal variances is performed, the null hypothesis states there is no significant difference between the two groups, H1 states the opposite. With $t(10) = 0{,}86$; $p<0{,}05$ H0 cannot be rejected. This indicates no significant differences in the outcome between the two types of planners. Analyzing the combined results of the equipment planners on the importance of the system characteristics is supported by this finding.

Table 4.3: Importance of characteristics per equipment planner type

System characteristic	Flow Analysts		Equipment Operators	
	Average	Std. Dev.	Average	Std. Dev.
Output Quality	4,78	0,44	4,62	0,79
Trialability	4,67	0,48	4,50	0,67
Perceived ease of use	4,39	0,65	4,59	0,62
Relative advantage	4,56	0,52	4,59	0,61
Objective usability	4,56	0,66	4,41	0,67
Perceived usefulness	4,28	0,66	4,32	0,68
Result demonstrability	4,44	0,66	4,41	0,70
Job relevance	4,28	0,73	4,03	1,12
Perceived enjoyment	4,00	0,64	4,03	0,97
Perceptions of external control	3,94	0,80	4,21	0,83
***t*-Test**				
Mean Flow Analysts	4,39			
Mean Equipment Operators	4,37			
df	17			
t	0,86			

The previous analyses indicate no differences between the different operational regions and types of planners. Therefore, the combined results are used to identify the most important system characteristics for equipment planners globally when adopting a new system. This is done via a statistical test, an ANOVA test, performed on the combined results from all types of equipment planners across all regions. ANOVA presents the average score and identifies if there are significant differences between the scores. This test is conducted with a null hypothesis, stating there is no significant difference between the average scores equipment planners assign to a characteristic, and H1 stating the opposite. The results are presented in Table 4.4. The outcome shows a significant difference between the average scores, $F(9) = 4{,}18$; $p<0{,}05$, therefore, H0 is rejected. The system characteristic 'output quality' has the highest average score and can be identified as the most important characteristic when adopting a new system. However, it is important to highlight the small differences between the characteristics. All have a high average score, with no characteristic scoring below 4 out of 5. Furthermore, the standard deviations of the characteristics can be defined as low.

Table 4.4: Importance of characteristics

System characteristic	Average	Std. Dev.	Sum
Output quality	4,61	0,73	258
Trialability	4,50	0,66	252
Perceived ease of use	4,46	0,81	250
Relative advantage	4,52	0,63	253
Objective usability	4,43	0,68	248
Perceived usefulness	4,27	0,84	239
Result demonstrability	4,39	0,71	246
Job relevance	4,07	0,99	228
Perceived enjoyment	4,00	0,85	224
Perceptions of external control	4,09	0,84	229
ANOVA			
df	9		
F	4,18		
P-Value	3,1E-05		

4.3.2. Perspectives on characteristics

This section will focus on equipment planners' perspectives on the PLP system, based on the defined system characteristics in Figure 3.6. Before analyzing these perspectives, it should be noted that not all statements in this segment are answered by all participants. Some questions could only be answered by participants who had previously used or were actively using the PLP system. This was mentioned in the question, and answering the question was not mandatory. These questions are marked with a (*) in the result tables. Table 4.5 presents the questions and the related system characteristic to the question.

Table 4.5: Questions and related system characteristic

Perspective	Related System characteristic
The system is relevant to the task I perform at my job	Job relevance
I think that the system is well developed to optimise my workflow (*)	Objective usability
I take the system's answer without revising them (*)	Output quality
The quality I get from the system is high (*)	Output quality
I find it easy to get the system to do what I want it to do (*)	Perceived ease of use
Interacting with the system does not require a lot of effort (*)	Perceived ease of use
The input the system needs from me is clear and understandable (*)	Perceived ease of use
Without looking at the output of the system, I enjoy using the system in my current workflow (*)	Perceived enjoyment
Within my work, I am always open to use/integrate new systems	Perceived enjoyment
Using the system enhances my effectiveness in my job (*)	Perceived usefulness
Using the system improves/or will improve the performance in my job	Perceived usefulness
If I have difficulties understanding the system, there are enough resources available I can consult (*)	Perceptions of external control
I feel like everything has been done to get me to understand the system	Perceptions of external control
The implementation of the system can improve the quality of my equipment planning	Relative advantage
I can understand the output of the system easily, without considering its content	Result demonstrability
When introducing a new system, I would like to test the usage in a test environment before actual implementation	Trialability
Exactly understanding the system before implementation is important to me	Trialability

Analyzing the perspective on the characteristic per region shows more difference than the regional importance on the criteria, as presented in Table 4.6. Previously, there was minimal difference between the average scores across the regions. Equipment planners' perspectives on the current system indicate a small distinction between the regions. The difference in usage of the current systems across the regions could explain these small differences. The range of the perspectives scores can be identified as the same, both positive and negative general thoughts are shared across all regions. To test if these differences are significant, a t-Test is performed similar to subsection 4.3.1. This result, $t(27) = 0{,}23$; $p<0{,}05$, shows no significant difference between the regions AFR and EUR. This shows that, even though there are differences between the average scores of the regions, the overall perspectives on the characteristics across the regions are shared.

Table 4.6: Perspectives on characteristics per region

Perspective	Average				
	AFR	AMR	APA	EUR	IME
The system is relevant to the task I perform at my job	4.40	3.82	3.86	3.96	4.29
I think that the system is well developed to optimise my workflow (*)	2.00	2.50	1.50	3.00	3.17
I take the system's answer without revising them (*)	1.67	2.40	1.50	1.91	2.33
The quality I get from the system is high (*)	2.33	2.80	1.60	2.71	3.00
I find it easy to get the system to do what I want it to do (*)	3.00	2.75	1.75	2.92	3.17
Interacting with the system does not require a lot of effort (*)	2.67	2.75	2.75	3.25	3.00
The input the system needs from me is clear and understandable (*)	3.00	2.50	2.00	3.79	3.17
Without looking at the output of the system, I enjoy using the system in my current workflow (*)	4.00	3.00	1.50	2.58	3.00
Within my work, I am always open to use/integrate new systems	4.20	4.18	3.86	4.42	4.43
Using the system enhances my effectiveness in my job (*)	3.33	2.25	1.50	2.92	4.00
Using the system improves/or will improve the performance in my job	3.60	3.73	2.29	3.35	4.14
If I have difficulties understanding the system, there are enough resources available I can consult (*)	2.33	2.25	3.00	3.25	2.83
I feel like everything has been done to get me to understand the system	2.80	3.36	2.29	3.58	3.14
The implementation of the system can improve the quality of my equipment planning	4.00	4.09	3.57	4.15	4.43
I can understand the output of the system easily, without considering its content (*)	1.67	2.00	2.00	3.38	3.33
When introducing a new system, I would like to test the usage in a test environment before the actual implementation	3.80	4.45	4.43	4.46	4.00
Exactly understanding the system before implementation is important to me	4.20	4.36	4.71	4.50	4.14
***t*-Test**					
Mean AFR	3.11				
Mean EUR	3.41				
df	30				
t	0.29				

Previous in this research, the differences in the implementation status and overall perspective of the system became clear via interviews. These interviews were conducted before the establishment of the conceptual model, to identify an initial overview of the problem. Although these findings provided interesting insights, a survey at this stage of the study can gather more detailed and company-wide data related to the adoption barriers. A t-Test is used to identify whether the equipment planners' scores on the characteristics' perspectives statistically differ. The null hypothesis states no difference between the two groups, H1 states the opposite. With $t(32)$ = 0,73; p<0,05 H0 cannot be rejected, and no statistical differences between the two equipment planners can be identified. This was also expected when looking at the average scores the two types assign to the perspectives, which is presented in Table 4.7. For each perspective, the Operators and the Flow Analysts have a similar score, with no difference greater than 0.42 out of 5. Therefore, analyzing the outcome of the perspectives on the characteristics is based on the grouped results of all types of equipment planners from all regions. The relatively high standard deviations of this analysis were to be anticipated. Each participant in the survey has a different level of knowledge and usage of the current system, which influences their perspectives. Even though a general explanation and goal of the system is given in the survey, latent thoughts still influence participants during the survey. The results of the analysis with the categories combined can be found in Table 4.8 and are further elaborated on in the following paragraph.

Table 4.7: Perspectives on characteristics per equipment planner type

Perspective	Flow Analysts		Equipment Operators	
	Average	Std. Dev.	Average	Std. Dev.
The system is relevant to the task I perform at my job	4,00	1,17	4.00	1,01
I think that the system is well developed to optimise my workflow (*)	2,81	1,28	2,72	1,14
I take the system's answer without revising them (*)	1,94	1.18	2,00	1,00
The quality I get from the system is high (*)	2,71	1,36	2,54	1,21
I find it easy to get the system to do what I want it to do (*)	3,00	1,10	2,72	1,10
Interacting with the system does not require a lot of effort (*)	3,00	1,10	3,12	1,05
The input the system needs from me is clear and understandable (*)	3,38	1,36	3,32	1,03
Without looking at the output of the system, I enjoy using the system in my current workflow (*)	2,94	1,34	2,52	1,00
Within my work, I am always open to use/integrate new systems	4,25	0,85	4,31	1,14
Using the system enhances my effectiveness in my job (*)	3,13	1,36	2,76	1,09
Using the system improves/or will improve the performance in my job	3,65	1,27	3,28	1,03
If I have difficulties understanding the system, there are enough resources available I can consult (*)	2,88	1,15	3,08	0,95
I feel like everything has been done to get me to understand the system	3,10	1,02	3,33	1,04
The implementation of the system can improve the quality of my equipment planning	4,25	0,79	4,00	0,93
I can understand the output of the system easily, without considering its content (*)	2,94	1,48	3,00	1,08
When introducing a new system I would like to test the usage in a test environment before the actual implementation	4,45	0,94	4,28	0,74
Exactly understanding the system before implementation is important to me	4,45	0,69	4,42	0,84
***t*-Test**				
Mean Flow Analysts	3.34			
Mean Equipment Operators	3.26			
df	32			
t	0.73			

First, an ANOVA test is performed to test the statistical differences between the perspectives. The outcome of this test shows a significant difference between the perspectives: $F(16) = 22{,}28$; $p<0{,}05$. Therefore, the average outcomes of the statements can be compared with each other. The relatively high standard deviation could be explained by the different levels of usage participants currently have with the system. An in-depth analysis of the results shows two important findings. The statements examining more general perspectives on a planning system scored relatively positive, with an average of 3.9 out of 5. On the other hand, nine statements examined the perspectives on the personal use and quality of the system. These were ranked as the lowest, scoring an average of 2.7 out of 5. Two statements regarding the system's output quality stand out most negatively, with one statement achieving the lowest average score of just 1.98 out of 5. In the first round of follow-up interviews, the negative perspective against the output quality of the system was validated (Appendix D.10 D.11). This holds for both users of the system who still plan most of their OTTs manually and users who let PLP plan

50% of their repositioning moves. Another important insight that became clear from these interviews was the influence the output quality of the system has on the other statements regarding personal use and usability. The output quality was considered so poor that it devalued the system's overall utility and potential. This is consistent with the findings of the importance of the criteria, where, despite minor differences, the output quality was identified as the most important criterion. It can be stated that the bottleneck in the adoption rate is the current output quality of the PLP system.

Table 4.8: Perspectives on characteristics

Perspective	Average	Std. Dev.	Sum
The system is relevant to the task I perform at my job	4,00	1,06	224
I think that the system is well developed to optimise my workflow (*)	2,76	1,18	113
I take the system's answer without revising them (*)	1,98	1,06	81
The quality I get from the system is high (*)	2,60	1,26	112
I find it easy to get the system to do what I want it to do (*)	2,83	1,09	116
Interacting with the system does not require a lot of effort (*)	3,07	1,06	126
The input the system needs from me is clear and understandable (*)	3,34	1,15	137
Without looking at the output of the system, I enjoy using the system in my current workflow (*)	2,68	1,15	110
Within my work, I am always open to use/integrate new systems	4,29	0,78	240
Using the system enhances my effectiveness in my job (*)	2,90	1,20	119
Using the system improves/or will improve the performance in my job	3,41	1,12	191
If I have difficulties understanding the system, there are enough resources available I can consult (*)	3,00	1,02	123
I feel like everything has been done to get me to understand the system	3,25	1,03	182
The implementation of the system can improve the quality of my equipment planning	4,09	0,88	229
I can understand the output of the system easily, without considering its content (*)	2,98	1,23	122
When introducing a new system I would like to test the usage in a test environment before the actual implementation	4,34	0,82	243
Exactly understanding the system before implementation is important to me	4,43	0,78	248
ANOVA			
df	16		
F	22.28		
P-Value	1.30E-53		

Consequently, in-depth interviews were conducted to examine the perceived output quality of the system. Interviews with both users and the system developer identified that not only the system's output itself is influencing the low adoption rate. The input, the calculations made by the system with this input, and the following suggestions continuously influence each other, and as a result, the perceived output quality (Appendix D.9.2 D.12 D.13). The implementation of constraints is perceived as a challenging task. The responsibility of inserting the correct input data and constraints lies with the system's users (Appendix D.9.2). As a result of difficulties with the data input, the optimisation algorithm is calculating with incorrect data when suggesting a repositioning move. This, in turn, leads to the invalidation of the suggestion made by the system, which users often experience as illogical and inconsistent with the repositioning plans they make manually. From an interview with the developer of the PLP system, this is only a result of the bad input data and not of the mathematical formulas that the system is using (Appendix D.9.2). However, it must be noted that users currently lack an understanding of the precise manner in which the system comes to an OTT suggestion, resulting in a lack of knowledge of where and how to change the input, which completes the sequence of reactions and returns to the first stage in the system.

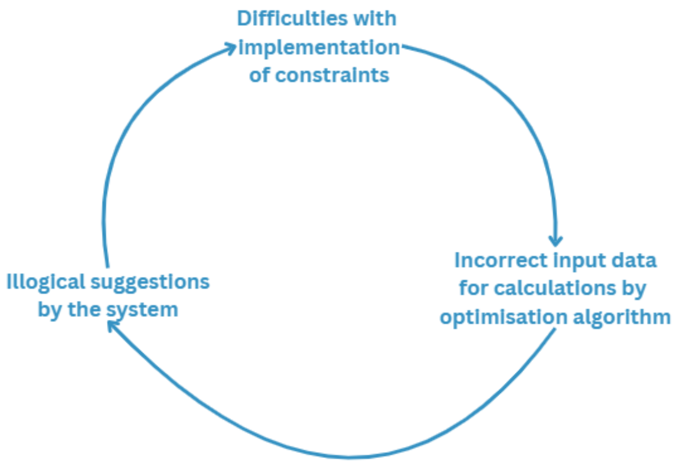

Figure 4.1: Perceived output quality

4.4. Reflecting on conceptual model

To identify the adoption barriers against the PLP system, the established model in Figure 3.6 is used. The influence of the identified system characteristics on the adoption of a new technology system in a company operating in the maritime sector was researched via a company-wide survey. The relative importance of each was initially evaluated to confirm the influence of the characteristics. Different analyses in subsection 4.3.1 confirm the importance of the characteristics when adopting a new technology system by the survey's target group. These findings support the study's thought that the established model is suitable for research on adopting a new technology system in a company in the maritime sector. Furthermore, this also supports the use of the model as a research instrument to examine the perspectives against the new system. Survey questions and in-depth interviews following, have identified the current adoption barriers of the automated planning system. The three demographic variables included in the final model have been included in the survey. Since these are not in line with the demographic distinction the company central in this case makes, these are not included in the analysis of the results. Identifying adoption barriers for different demographic groups than the organization makes would not be beneficial in solving this adoption problem. However, this can vary per company and could, therefore, still be of added value when researching the adoption of a new technology in the maritime sector.

4.5. Improving adoption

To increase the system's adoption rate, it is essential to focus on two key areas: the system itself and user resistance to it. As becomes clear in Figure 4.1, these two areas constantly influence each other, making it important to address them simultaneously. This idea is supported by a former PLP developer who successfully developed and implemented a system based on an optimization algorithm at another company. According to him, the success of a new system is 50% the system itself and 50% getting the users on board regarding the implementation. To get users on board the new system, it is important to ensure that users perceive themselves as integral to the system rather than as mere subordinates (Appendix D.14). Involving users in the development and use of the system will be underlying in the recommendations to increase the system's adoption rate. The recommendations are formulated following the output of the survey, follow-up interviews with participants and the system developer, and the example of successful implementation (Appendix D.9 - D.14). The recommendations are set out in a five-step road map, which is presented in the following subsections. Since both types of equipment planners are using the automated planning system similarly, and no significant differences could be identified when analyzing the survey results, the road map for improving the adoption is generally designed for each non-user of the system.

1. Added value of using automated planning system

Analyzing the survey results reveals the importance of the characteristics of 'job relevance' and 'relative advantage' to the participants. The results of the questions on the perspectives show that these characteristics are well-valued in the current system and that the target group of the system is open to integrating new systems in their workflow. However, follow-up interviews reveal that current non-users of the system are satisfied with the current workflow in which they manually plan all repositioning moves, resulting in no direct incentive for adopting the automated system (Appendix D.10 D.11 D.12 D.13). Despite the fact that the previously mentioned high score of the system characteristics should be sufficient to encourage the adoption of the new system, the process of manually creating a repositioning plan is still considered to be of great value. Therefore, the first step in improving the adoption rate is to clarify the added value of the PLP system. Presentations that have been given in the past do not provide sufficient evidence to non-users to demonstrate the system's added value compared to the manual workflow.

Reviewing these presentations, most attention has been given to the new system's functioning. However, it is recommended to present where or how the current workflow is insufficient and how the new system will optimize this. A new presentation, with the correct use of interesting visuals, can show the added value of the automated planning system over the manual workflow. Furthermore, it is important that a suitable candidate is selected to present this presentation to the equipment planners. Even though the decisions regarding this system have been made from a top-down point of view, users should perceive themselves as integral to the system, rather than it being imposed on them (Appendix D.4 D.14). This will limit the risk of even bigger resistance and fear of replacement by the system. A suitable candidate for this presentation would be someone directly managing the equipment planners. This person is expected to see the added value of integrating the system from a strategic viewpoint while also having enough knowledge to explain the added value for the operations. The objective is that this presentation will present the added value to current non-users of the system, and the first step in reducing the resistance is taken.

2. Functioning of algorithm

Following the presentation, it is possible to proceed to the next stage of the road map. This stage will zoom into the functioning of an algorithm in general, which, together with the first step, will present how the automated system optimizes manual planning. As became clear during follow-up interviews, users lack understanding of how the system arrives at its output, influencing the overall resistance against the system. Therefore, explaining the workings of the optimiser to the current non-users is recommended. Once more, the objective is to demonstrate and highlight the users' role in the system. This can be achieved by organizing a workshop where users can test and understand the system's working and an algorithm in general. Creating a beta version of the PLP system in which only a few constraints can be adjusted to see how this influences the system's suggested OTT. According to the previously mentioned former employee of Maersk, the ability to test is one of the reasons for successfully implementing the airline crew planning optimizer (Appendix D.14). Next to this successful example is the ability to test the system in line with the survey result in which the perspectives on the criteria 'trialability' scored the highest average (Table 4.8). It can, therefore, be assumed that users are open to participating in this workshop. The most suitable person to host this workshop is someone involved in the development of the PLP system. This person has substantial knowledge of an algorithm in general and has the capabilities to link general questions to the functioning of the PLP system.

After steps one and two are performed, a measuring moment can be applied to ascertain whether the resistance has already decreased. This can be done by asking around if users are testing with the system. Currently, most non-users have set constraints to limit the system's workings. When these types of constraints have been removed to test with the system, steps one and two can be seen as successful.

3. Improving the system

After reducing the resistance to the system in the previous steps, this step will focus on improving the system by the users and developers. A deeper understanding of the system's lack of output quality made it clear that this is mainly due to the mismatch between the system's design and an equipment planner's requirements when making a repositioning plan. This is particularly relevant in cases of repositioning between inland locations. These repositioning moves often happen ad-hoc and result from direct contact between an Equipment Operator and a barge operator who is not an employee of the same company. As mentioned in this research, the current version of the PLP system suggests repositioning moves on pool level; therefore, constraints are also put in on pool level, whereas Equipment

Operators plan on site level. Furthermore, multiple equipment planners experience the input screens in ROCK as non-user-friendly, which prevents them from understanding the systems and needed input. As became clear in Chapter 2.2, the repositioning plans of Equipment Operators and Equipment Flow Analysts are interlinked. This also ensures that poor input by the Operators in the system also results in a poorly suggested repositioning plan by OTT for the Flow Analysts.

These examples of mismatches between the system and the requirements of the planners are only three development flaws that became clear when researching the input the system needs. From interviewing survey participants, more (minor) flaws preventing users from adopting the system became clear (Appendix D.10 D.11 D.12 D.13). Users don't know where to address these problems explicitly, whereas the system developer has stated that he does not believe he receives all complaints. To make it clear for users and to protect one developer from getting complaints, questions or suggestions from each user separately, it is recommended that one *focal point* per region be designated. This focal point will be the missing link between the operational users globally spread and the developers in Copenhagen. When contacting the systems developer, this focal point will represent the user's wishes and needs. There are two elements worth highlighting when selecting a focal point. First, it is important to have a proper ratio of equipment planners represented and focal points. In regions with many planners, e.g. Europe, having more than one focal point is recommended. Furthermore, it is recommended that this individual has a decent level of knowledge about both the operations and the system. This is expected to result in critical conversations with the Flow Analysts and Operators to discuss their needs while considering the objective of the developed system. But also the other way around when discussing the system's further development with the developer.

4. Increase confidence in the system

To increase confidence in the developed system, it is recommended that the improvements made in the previous step be visible to all equipment planners. This will show equipment planners that their input is taken seriously and that the system is optimized to match their requirements when creating a repositioning plan. It is expected that this will increase the confidence of non-users in the system and encourage them to implement it in their workflow. Showing the improvement can, for example, be done via a (weekly) e-mail update.

Measuring the success of the third and fourth steps can be done via survey, or more specifically, the Q-method. This method allows for systematically testing opinions and perspectives [66]. Should it be apparent that the confidence in the system has grown and resistance against it has reduced, a positive shift in the equipment planners' opinions can be indicated. To have an increase in the adoption of the new system and keep all the non-users involved, it is important to constantly measure this potential shift. Once this shift has occurred, the road map's final step can be started.

5. Improve the use of the system

The final step will focus on improving the use of the constraints in the system. This will positively affect all three elements of Figure 4.1. In addition to understanding an algorithm in general, users would also like to understand the process of the algorithm arriving at an OTT in ROCK. Presenting the constraints primarily utilized in the OTT determination will facilitate understanding which input resulted in this output. As it is unlikely that equipment planners will utilise the system's full functionality after these recommendations have been executed, it is also advisable to have a period of familiarisation with the system. This can be done by presenting the utilized constraints when creating a manual OTT. The previously mentioned focal point will also play a key role in this step to ensure proper implementation. If the outcomes of the suggestions remain unclear, users can inform the focal point which will contact the developers.

Measuring the increased adoption and reduced resistance after this final step can be done by measuring the number of OTTs suggested and accepted by the system. Analyzing these numbers over a period of time will indicate the success of this road map.

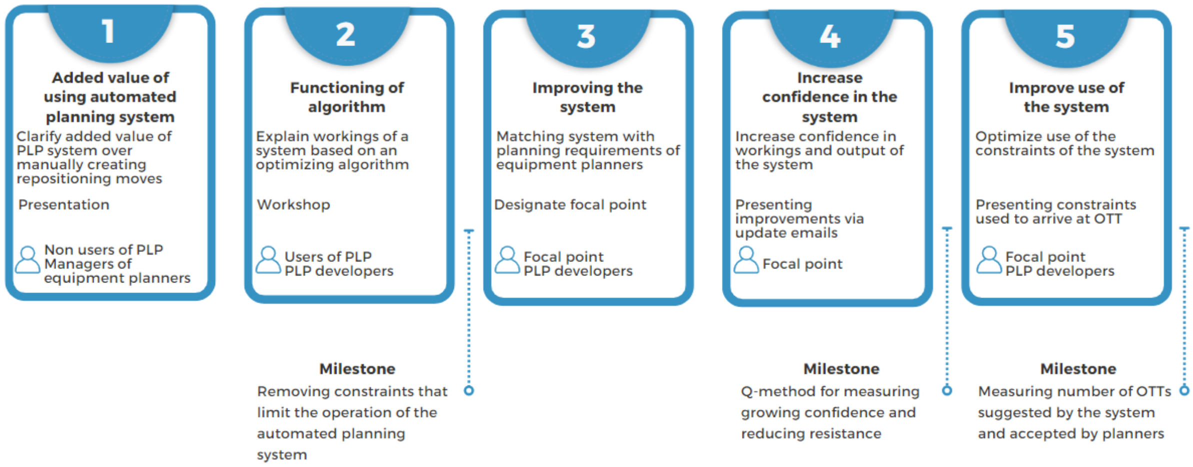

Figure 4.2: Road map to improve adoption rate of the PLP system

4.5.1. Execution of road map

This road map is designed with the focus on current non-users of the system. It is expected that systematically following these steps will turn non-users into users of the automated planning system. For equipment planners which are already using the system, following this road map is not necessary. For this group, the focus can already go to improving their use of the system, by executing step 5. Since the execution of this step can not be limited to one user or group of users specific, all equipment planners will see the implementation of this step. However, it is expected that current non-users of the system will not yet pay attention to this change when they have not yet followed the previous steps.

Despite the fact that the system will optimise repositioning moves on a global scale once all equipment planners have adopted the system, it is recommended that the road map be implemented on a regional basis. This ensures that planners have more time to familiarise themselves with the system before it is integrated into the global network. Once users have adjusted to using the system, the operational scope of the system will gradually follow. This way of executing the road map is possible since equipment planners can still cancel OTTs suggested by the system. However, is it expected that the number of cancelled OTTs will lower over time, similarly as the expansion of the operational scope. This can be measured as mentioned in step five.

4.6. Takeaways Chapter 4

The survey conducted in this chapter was done to answer the third sub-question:

SQ3: "What barriers do planners of empty containers have to implementing and adopting an automated planning system?"

Based on the survey and follow-up interviews' outputs, the system's characteristic output quality can be identified as the biggest barrier to users' adoption of the system. Follow-up interviews revealed the factors influencing this characteristic. Users address the mismatch between the designed system and their way of creating a repositioning plan; the lack of understanding of the required inputs the system needs and the output it is generating; and a missing contact point to address their problems with the system. These three factors can be listed as the adoption barriers for planners to adopt the new automated planning system.

These findings are used to answer the final sub-question of this research:

SQ4: "What is needed to overcome the implementation and adoption barriers to improve the adoption rate of an automated planning system?"

A five-step road map is drafted to improve the adoption rate of the planning system. All steps focus on improving the system's quality and reducing resistance while involving users. The first step will highlight the added value of the automated planning system over manually creating a repositioning plan. The following step focuses on the functioning of an algorithm in general to show the importance of input data given to the system by the users. It is expected that these two steps initiate reducing resistance. After analyzing the effect of the first two steps, step three can start, which will improve the system itself. For this, it is recommended to designate a focal point per operational region. This focal point will form the missing link between the developers and users of the system when matching the system to the operational requirements of the equipment planners. To increase confidence in the system, the fourth step recommends presenting improvements made to the system. The final step can be started once a shift from resistance against the system to confidence in the system is measured. After this is measured, one can focus on improving the use of the planning system. This can be done by presenting the constraints used by the system to arrive at the suggested OTT. This will facilitate understanding which input influences the output.

5 Discussion

This chapter will delve deeper into the conclusions drawn in Chapter 4's takeaways. The results will be interpreted and examined within the established theoretical framework. Furthermore, the limitations of the study and the opportunities for further research will be addressed.

5.1. Discussion

The results from the survey and interviews conducted in Chapter 4 reveal the root cause of the lagging adoption of the automated planning system by equipment planners working for Maersk. The survey results show that multiple system characteristics of a new technology influence the adoption rate by users. However, the system characteristic 'output quality' has the most impact on the current adoption rate of the technology central to this study. Although it was anticipated that in the event of an issue with an algorithmic optimizer, the output would be the primary concern, this study shows a more nuanced understanding of this matter. By systematically and in-depth analyzing the problem, it becomes clear that the other factors influence the perceived output quality in this problem. This would not have been revealed when the focus had gone directly and only to the output of the planning system. The mismatch with the current way of planning, failure to understand the input constraints and, therefore, the suggested OTT, lacking a general understanding of an algorithm and a clear point of contact all contribute to the perceived output quality and, subsequently, the resistance to adoption.

These findings show that the use of the TAM model by Davis is suitable for researching the adoption problem of the new automated planning system [23]. However, as mentioned, only focusing on the influence of system characteristics would not have been sufficient to identify the root cause of the lagging adoption. This study shows that in-depth research is required on the concept of a system characteristic to identify the root cause. Only when the root cause is found, suitable recommendations can be drafted to improve the adoption rate of a new system.

The results of a system characteristic influencing the adoption of the new system align with the hypothesis from Davis [23]. He stated that different characteristics are influencing the two beliefs of the TAM, which in turn influence the adoption of a new system. Multiple studies already supported this hypothesis, however, these did not focus on a technology or sector similar to an automated planning system in the maritime sector. This study contributes to literature related to the TAM by finding relevant system characteristics for this sector and, or similar technologies. Furthermore, this study presents a systematic way of analyzing an adoption problem and eventually identifying a root cause of lagging adoption when using the TAM, which could be generally used when using the TAM in adoption problems.

5.2. Limitations

Although this study has yielded valuable insights, it is also essential to acknowledge its limitations. Firstly, it is important to highlight the data employed for this research. The data was only gathered within the scope of Maersk's operations, resulting in conclusions and recommendations specifically drafted for this company. Attention has not been given to the comparison or differences in the repositioning process of empty containers at other liner shipping companies. The survey's target group consisted solely of individuals employed by Maersk. Since this company was chosen as a unit of analysis for the case study, it is not a problem for the conclusions drawn in this research. However, it can limit the generalizability of the outcome.

Another limitation worth highlighting is the role of the TAM in this research. In this study, the TAM is used to identify system characteristics of the new technology that affect its adoption. The adoption problem has not been tested across the other characteristics of the TAM. No consideration has been given to potential correlations between system characteristics themselves and between system characteristics and the beliefs of the TAM. Even though an adoption barrier and enablers to this are identified, not researching potential correlations could have implications. This limitation can result in an overly focused view on one system characteristic, whereas multiple could be relevant. Consequently, a recommendation that is not aligned with the actual adoption barrier could be drafted. This limitation can be explained by the use of the data analyzing program. In this study, only Microsoft Excel is used, which is not capable of supporting research of these types of correlations.

Researching perspectives via a survey could also be a limitation of this study. Despite being a suitable method to gather data from a large cohort at once, this method does not support revealing latent variables participants have regarding the perspectives. As a consequence, it is possible that factors affecting the system's adoption may be overlooked. Thereafter, this may result in only a partial understanding of the nature of the adoption barriers.

Lastly, the possible changing role of an equipment planner when completely integrating the new system into the workflow can be a limitation. This was mentioned briefly but not included in the study for further research. Since this study focuses on the adoption barriers against the algorithm, and this shift is not necessary for the initial implementation, no further attention has been given to this element. However, not researching this potential shift can result in unexpected implications for optimal operations.

5.3. Further research

Expanding on the results and limitations of this study, three directions for further research can be listed.

As mentioned in the previous section, the potential correlation between the identified system characteristics has not yet been researched. Revealing these correlations can affect the drafted road map and improve the adoption rate. It is recommended that these potential correlations be analysed to better understand the adoption barriers against implementing a new technology system. This could be done via a similar research method presented in this study; however, a different statistical analysis program would be necessary. Programs suitable and recommended for this type of research are SPSS and R-Studio. The system characteristics identified in this study could still be used, as their influence and importance in adopting a new system have been proven. When correlations between the system characteristics are identified, recommendations can be drafted which align even better with the adoption barrier.

The next recommendation for further research can be executed as a direct result of this study. As mentioned in the previous section, no attention has been given to the potential shift in the role of an equipment planner. At present, the equipment planner fulfils primarily the role of a planner. However, it is anticipated that when the automated planning system reaches optimal functionality, this role will evolve into a more analyst one. This is mostly an assumption, as no research has been done on this topic. Since this could have big implications for the operations, further research should focus on this.

The third direction for further research is recommended when this study is employed as a basis for another case. This study did not analyse the survey outcomes based on all the demographics included in the final model since this was not relevant for the company central to the case study. However, the influence of demographics on the adoption of an automated planning system is an interesting topic to study in further research. This study could focus on the adoption barriers per demographic and possible related implementation strategies.

6 Conclusion

Due to global trade imbalances, there are many cases where empty containers are not stored at the location where they are needed. In response, a worldwide network of repositioning empty containers has been established. Since carriers incur the costs of these repositioning moves, the objective is to keep the number of these moves as low as possible and optimise the planning of such operations. Literature shows that the use of an optimising planning algorithm is suitable for this end. Implementing systems based on this technology within an organisation is often met with several barriers. Since no examples of implementing an automated planning system in the maritime shipping industry can be found in the literature, it is unclear whether these general barriers can be projected to optimise the repositioning moves for empty containers. The objective of this study is to fill this knowledge gap by answering the following research question:

”What are the adoption barriers and enablers for implementing an automated planning system in the planning of the empty container flow at a liner shipping company?”

To answer this question, qualitative research, with an exploratory approach, has been conducted. The case study of the global operating shipping company Maersk was the central focus of this research, which examined the lagging adoption of their automated planning system for empty containers.

The study began with answering the first sub-questions to gain a comprehensive understanding of the case. This was done by examining a planner’s workflow when creating a repositioning move, both without and with the new planning system implemented. These results show that the main difference between the two workflows lies within the criteria and constraints considered when planning a repositioning move. Manually creating a repositioning move only considers three parameters, whereas the algorithm of the planning system considers 23 input parameters. This difference has a notable impact on optimising the repositioning moves. Furthermore, findings demonstrate that the new system is not intended to replace existing planners; its output depends on the equipment planners’ input to achieve optimal results.

The second sub-question focused on identifying relevant system characteristics to the system central. The Technology Acceptance Model by Davis only lists these factors as a hypothesis, with no clear definition [23]. As an answer to this sub-question, a conceptual framework with system characteristics based on the TAM was established. These system characteristics were used in a survey to answer the third sub-question of this study. The survey identified the system characteristic ’output quality’ as the most influential factor in the lagging adoption of the planning system. Follow-up interviews with (non) users of the system revealed that not only the actual output could be listed under this characteristic, but more factors are considered to influence the output quality. These results are the answer to the first part of the main research question of this study. The barriers against the adoption of an automated planning system are the mismatch between the developed system and the manual workflow of creating a repositioning move for an empty container, the lack of understanding of both the algorithm itself and the required input and a missing point of contact to address problems and questions. These barriers reinforce each other and decrease the output quality of the system.

To answer the last sub-question and the second part of this study's main research question, recommendations are given to improve the system's adoption rate based on the identified barriers. It is recommended to focus on improving the system itself and reducing resistance to it. To achieve this, a five-step road map is drafted, involving the system's users in these steps. The first step will highlight the added value of the automated planning system over manually creating a repositioning plan. The following step focuses on the functioning of an algorithm in general to show the importance of input data given to the system by the users. To improve the quality of the system itself, it is recommended that a focal point be designated per operational area, which forms the missing link between the users and the developers of the system. To increase confidence in the system, the fourth step recommends presenting improvements made to the system. The fifth and final step of the road map focuses on improving the use of the planning system by presenting the constraints used by the system to arrive at the suggested OTT. This will facilitate understanding which input influences the output.

In conclusion, this study provides valuable insights that contribute to the company central in the case study and to the broader field of science. To Maersk, this study has practically identified the lagging adoption of the automated planning system, PLP. Several adoption barriers have been identified, and a road map to overcome these barriers has been established. It is expected that when following the steps of the road map, the flow of repositioning empty containers will be optimised, resulting in a reduction of operational costs. To science, this study demonstrates the suitability of the system characteristics of the TAM in addressing an adoption issue in the maritime sector. This represents a novel approach in this sector. The system characteristics identified for this adoption problem might be specific. However, this study presents how to scientifically come to relevant system characteristics and the root cause of technology adoption problems in general.

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A

Literature review

A.1. Method

Finding the correct literature for this literature review was done in three steps. Firstly, available literature on the topic of empty container repositioning and planning in general was searched. This was done to get a better understanding of the topic and scope this problem is operating in. This broad exploration was done on Scopus and websites related to the maritime industry. With this general knowledge, a more detailed approach followed where specific search strings on Scopus were used to find peer-reviewed articles related to using planning algorithms in the container flow and the acceptance of such. The following search strings were used to this end:

- ”algorithm implementation” AND ”logistics industry”
- ”planning algorithm” AND ”logistics industry”
- digitalization AND ”empty container planning”

Lastly, since not many articles were found on the acceptance in the maritime industry specifically, research was done on implementing technology tools in general in this industry. This was also done using two search strings on Scopus.

- ”implementation barriers” AND ”technology of implementation barriers” AND logistics
- blockchain AND ”maritime OR shipping” AND ”adoption OR implementation OR application” AND barrier

The articles selected for this literature review can be found in Table A.1.

A.2. Core concepts

To have a clear understanding of what is stated in the literature review, some core concepts need to be elaborated on. The main topic of this review is optimizing the planning of empty container flow. Empty container repositioning results from the need for harmonization between the point of empty container accumulation and the point of demand [46]. To optimize this planning, an algorithm can be used. A planning algorithm allows one to select the best quality plan to answer a query by cutting off poor-quality sources and generating several planning routes [98]. In this review, this is also referred to as a technology tool. Lastly, the implementation of a blockchain network is also discussed. A blockchain is a digital ledger that facilitates decentralized databases by relying on the consensus of all network participants to authorize any changes, serving a central role in recording and tracking assets and transactions within the maritime business [21].

Table A.1: Articles used in literature review

Title	Author	Year	Retrieved	Category
A Technology Acceptance Model for empirically Testing new end-user Information Systems: Theory and results	Davis	1985	Search string on Scopus	Technology acceptance
Allocation of empty containers between multi-ports	Li et al.	2007	Foreword snowballing	Algorithm use
Applying Blockchain technology: Evidence from Norwegian companies	Gausdal et al.	2018	Search string on Scopus	Technology implementation
Barriers to applying last-mile logistics in the Egyptian market: an extension of the technology acceptance model	Sultan et al.	2023	Search string on Scopus	Technology acceptance
Blockchain Adoption for Sustainable Supply Chain Management: Economic, Environmental, and Social	Munir et al.	2022	Search string on Scopus	Technology implementation
Blockchain adoption in the maritime supply chain: Examining barriers and salient stakeholders in containerized international trade	Balci and Surucu-Balci	2022	Search string on Scopus	Technology implementation
Cargo routing and empty container repositioning in multiple shipping services	Song and Dong	2012	Search string on Scopus	Algorithm use
Factors that affect acceptance and use of information systems within the Maritime industry in developing countries: The case of Ghana	Wiafe et al.	2019	Search string on Scopus	Technology acceptance
Liner Shipping Cargo Allocation with Repositioning of Empty Containers	Brouer et al.	2011	Foreword snowballing	Algorithm use
Measuring barriers in adoption of blockchain in supply chain management system	Chouhan et al.	2021	Search string on Scopus	Technology implementation
Multi-period empty container repositioning with stochastic demand and lost sales	Zhang et al.	2014	Foreword snowballing	Algorithm use
Online communities as a driver for patient empowerment: Systematic review	Johansson et al.	2021	Foreword snowballing	Technology acceptance
Simulated global empty containers repositioning using Agent-based modeling	Abdelshafie et al.	2023	Search string on Scopus	Algorithm use
Sustainable shipping management: Definitions, critical success factors, drivers and performance	Chua et al.	2023	Search string on Scopus	Technology acceptance
The (non-) application of blockchain technology in the Greek shipping industry	Papathansiou et al.	2020	Foreword snowballing	Technology implementation

B

Literature review TAM extensions

B.1. Articles between 1986 and 2013

Articles with extensions of the TAM between 1986 and 2023. These articles are selected by Marangunic and Granic (2015), one of the selected articles has been removed from this selection since the author of this thesis did not have access to it [58].

Table B.1: Selected articles from literature review between 1986 and 2013 [58]

Author	Title	Field of interest
Arning and Ziefle [8]	Understanding age differences in PDA acceptance and performance	Age
Barki and Hartwick [10]	User participation, conflict, and conflict resolution: the mediation roles of influence	Information systems
Chau [15]	An empirical investigation on factors affecting the acceptance of CASE by systems developers	System development
Chow et al. [18]	Extending the technology acceptance model to explore the intention to use Second Life for enhancing healthcare education	Healthcare education

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Table B.1 – continued from previous page

Author	Title	Field of interest
Dishaw and Strong [27]	Extending the technology acceptance model with task-technology fit constructs	Banking, Aerospace manufacturing, Insurance
Gefen and Staub [35]	Gender difference in the perception and use of E-mail: an extension to the technology acceptance mode	Email systems
Gumussoy et al. [7]	Understanding the behavioral intention to use ERP systems: an extended technology acceptance model	ERP systems
Igabaria et al. [40]	Why do individuals use computer technology? A Finnish case study	Computer usage
Jackson et al. [41]	Toward an understanding of the behavioural intention to use an information system	Accounting
Karahanna et al. [45]	Information technology adoption across time: a cross-sectional comparison of pre adoption and post-adoption beliefs	Banking
Lee and Letho [49]	User acceptance of YouTube for procedural learning: an extension of the technology acceptance model	Procedural education
Lin and Wu [52]	An empirical study of end-user computing acceptance factors in small and medium enterprises in Taiwan: analyzed by structural equation modelling	Small, medium enterprises
Lucas and Spitler [53]	Technology use and performance: a field study of broker workstations	Banking
Mathieson et al. [59]	Extending the technology acceptance model: the influence of perceived user resources	Accounting
Plouffe et al. [70]	Research report: richness versus parsimony in modeling technology adoption decisions-understanding merchant adoption of a smart card based payment system	Banking
Schepers and Wetzels [75]	A meta-analysis of the technology acceptance model: investigating subjective norm and moderation effects	Literature analysis
Taylor and Todd [81]	Understanding information technology usage: a test of competing models	Business school
Venkatesh [88]	Creation of favorable user perceptions exploring the role of intrinsic motivation	Broad
Venkatesh [91]	Determinants of perceived ease of use: integrating control, intrinsic motivation, and emotion into the technology acceptance model	Broad
Venkatesh and Morris [92]	Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior	Undefined

B.2. Articles between 2014 and 2023

These articles are found on the search engine ”Scopus” using the following search string and applied filters:

- *TAM AND ”Technology Acceptance Model” AND extension AND determinants*
- Published between 2014 and 2023
- Final publication stage
- Published in English

Table B.2: Selected articles from Scopus between 2014 and 2023

Author	Title	Field of interest
Abdallah et al. [1]	Determinants of M-commerce adoption: An empirical study	M-commerce
Al-Adwan et al. [3]	Extending the Technology Acceptance Model (TAM) to Predict University Students' Intentions to Use Metaverse-Based Learning Platforms	E-learning
Al-Emran [30]	Beyond technology acceptance: Development and evaluation of technology-environmental, economic, and social sustainability theory	Sustainability
Alnasrallah and Saleem [4]	Determinants of the Digitalization of Accounting in an Emerging Market: The Roles of Organizational Support and Job Relevance	Accounting
Alshurideh et al. [6]	Understanding the quality determinants that influence the intention to use the mobile learning platforms: A practical study	Education
Buschmann et al. [14]	An integrated model of the theory of reasoned action and technology acceptance model to predict the consumers' intentions to adopt electric carsharing in Taiwan	Car sharing
Feng et al. [31]	Determinants of Technology Acceptance: Two Model-Based Meta-Analytic Reviews	Literature Review
Fosso Wamba [93]	Determinants of Mobile Wallet Adoption: A Longitudinal Approach Applying an Extension of the Technology Acceptance Model in Cameroon	Banking
Granić [37]	Educational Technology Adoption: A systematic review	E-learning
Hoang et al. [38]	Determinants of Intention to Borrow Consumer Credit in Vietnam: Application and Extension of Technology Acceptance Model	Banking
Hussain et al. [39]	Antecedents to user adoption of interactive mobile maps	Mobile maps
Jimenez et al. [42]	Validation of a tam extension in agriculture: Exploring the determinants of acceptance of an e-learning platform	E-learning
Jimenez et al. [43]	Commonly used external tam variables in e-learning, agriculture and virtual reality applications	E-learning
Kaur and Sharma [47]	Factors affecting behavioural intentions to use e-banking services: an extension of TAM in Indian context	Banking
Li [51]	Determinants of College Students' Actual Use of AI-Based Systems: An Extension of the Technology Acceptance Model	AI-based Systems

Continued on next page

Table B.2 – continued from previous page

Author	Title	Field of interest
Makmor et al. [57]	Social commerce an extended technology acceptance model: The mediating effect of perceived ease of use and perceived usefulness	Social commerce
Mehra et al. [60]	Determinants of mobile apps adoption among young adults: theoretical extension and analysis	Mobile Applications
Mohapatra et al. [61]	Study of motivational factors post-implementing ERP (SAP) solutions in National Aluminium Company Limited extending the technology acceptance model at organisation level (TAMO)	ERP
Muñoz-Leiva et al. [64]	Determinants of intention to use the mobile banking apps: An extension of the classic TAM model	Banking
Nagy [65]	Evaluation of online video usage and learning satisfaction: An extension of the technology acceptance model	E-learning
Nguyen Thi et al. [84]	Factors influencing continuance intention of online shopping of generation Y and Z during the new normal in Vietnam	Online shopping
Okoro et al. [67]	Determinants of immersive technology acceptance in the construction industry: management perspective	Construction
Park et al. [69]	Investigating the determinants of construction professionals' acceptance of web-based training: An extension of the technology acceptance model	E-learning
Shaikh et al. [76]	Acceptance of Islamic financial technology (FinTech) banking services by Malaysian users: an extension of technology acceptance model	Banking
Taheri et al. [80]	The intentions of agricultural professionals towards diffusing wireless sensor networks: Application of technology acceptance model in Southwest Iran	Agriculture
Teo et al. [82]	The role of attachment in Facebook usage: a study of Canadian college students	Social Media
Tsai et al. [86]	What Drives Event Discovery Apps Users Behaviors Among Generation Z? Evidence From Macau	Mobile Applications
Yusliza et al. [101]	Determinants of continued usage intention of electronic human resource management	E-HRM

C

Determinants Technology Acceptance Models

C.1. Definitions of all determinants used in technology acceptance models combined

Table C.1: Definitions of determinants Technology Acceptance Models

Determinant	Definition	Original model
Computer Self-Efficacy	The degree to which an individual believes that he or she can perform a specific task/job using the computer [90]	Perceived Ease of Use
Perceptions of External Control	The degree to which an individual believes that organisational and technical resources exist to support the use of the system [90]	Perceived Ease of Use
Computer Anxiety	The degree of an individual apprehension or even fear when she or he is faced with the possibility of using computers [90]	Perceived Ease of Use
Computer Playfulness	The degree of cognitive spontaneity in microcomputer interactions [90]	Perceived Ease of Use
Perceived Enjoyment	The extent to which the activity of using a specific system is perceived to be enjoyable in its own rights, aside from any performance consequences resulting from system use [90]	Perceived Ease of Use
Objective Usability	A comparison of systems based on the actual level of effort required to complete specific tasks [90]	Perceived Ease of Use
Voluntariness		TAM2
Experience	Moderating effect when more experience with the system is gained	TAM2
Subjective Norm	The degree to which an individual perceives that most people who are important to him think he should or should not use the system [90]	TAM2
Image	Degree to which an individual perceives that the use of innovation will enhance his or her status in his or her social system [90]	TAM2
Job Relevance	The degree to which an individual believes that the target system applies to his or her job [90]	TAM2
Output Quality	The degree to which an individual believes that the system performs his or her tasks well [90]	TAM2

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Table C.1 – continued from previous page

Determinant	Definition	Original model
Result Demonstrability	The degree to which an individual believes that the results of using a system are tangible, observable, and communicable [90]	TAM2
Relative Advantage	The degree to which an innovation is seen as better than the idea, program, or product it replaces [26]	DOI
Compatibility	How consistent the innovation is with the values, experiences, and needs of the potential adopters [26]	DOI
Complexity	How difficult the innovation is to understand and/or use [26]	DOI
Trialability	The extent to which the innovation can be tested or experimented with before a commitment to adopt is made [26]	DOI
Observability	The extent to which the innovation provides tangible results [26]	DOI
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance [87]	UTAUT
Effort Expectancy	The degree of ease associated with the use of the system. Perceived ease of use from TAM [87]	UTAUT
Social Influence	The degree to which an individual perceives that important others believe he or she should use the new system [87]	UTAUT
Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system [87]	UTAUT

C.2. Determinants in-or excluded for research

Table C.2: Support for in- or excluding determinants

Determinant	In- or Excluded	Reason
Computer Self-Efficacy	Excluded	Users are already using a computer to perform their job
Perceptions of External Control	Included	New function of the system for which support will be needed when implemented
Computer Anxiety	Excluded	Users are already using a computer for perform their job
Computer Playfulness	Excluded	
Perceived Enjoyment	Included	Can also measure the possible frustration against the implementation of the system, important to understand if there currently is any frustration
Objective Usability	Included	To measure what users think about the current usability of the system, if there is something that needs to change relating to this aspect
Voluntariness	Excluded	Became already clear from previous interviews that there is no pressure to use this system
Experience	Included	To test the influence of people who are already working with the system , have worked with the system in the past, and people who have no experience with working with the system
Subjective Norm	Excluded	It is not about the acceptance of a technology that will be visible to others
Image	Excluded	It is not about the acceptance of a technology that will be visible to others

Continued on next page

Table C.2 – continued from previous page

Determinant	In- or Excluded	Reason
Job Relevance	Included	Implementation of technology will have effect on the job of users
Output Quality	Included	Implementation of technology will have effect on the job of users
Result Demonstrability	Included	Implementation of technology will have effect on the job of users
Relative Advantage	Included	To test whether users understand the usefulness of the development
Compatibility	Excluded	Already captured in ’Output Quality’
Complexity	Excluded	Already captured in ’Objective Usability’
Trialability	Included	To test whether users would like to test the system before implementation
Observability	Excluded	Already captured in ’Ouptut Quality’
Performance Expectancy	Excluded	Group construct derived from other models already included
Effort Expectancy	Excluded	Group construct derived from other models already included
Social Influence	Excluded	Group construct derived from other models already included
Facilitating Conditions	Excluded	Group construct derived from other models already included

D

Interview transcripts

A lot of the company-specific information that is needed in this research is gained through the experience of the researcher working at the company. However, since this is not possible for all the needed information, interviews were conducted with employees of the company. Most of these interviews were conducted in real life and recorded for further analysis. Some of the interview statements are conducted via a conversation on Teams with the participant, only the conversations that include statements used in this research are presented in the transcripts of the interviews. Other conversations with employees are assumed to gather general knowledge about the problem and system.

All participants were requested to sign a 'Informed Consent' form before starting the interview. This is signed by all participants and stored on the computer of the researcher to preserve anonymity in this research publication.

Most of the interviews are conducted in English, and some of them are conducted in Dutch. However, since the researcher, the university supervisors, and the company supervisor are all fluent in Dutch, it was not chosen to translate these interviews.

The text highlighted in **bold** represent the questions asked by the interviewer, answers to the questions are presented right after this question.

D.1. Equipment Manager

Wat zou je zeggen dat het target van Equipment Operators is? Dit gaat dan vooral waar zij in dit systeem op kunnen worden afgerekend door bijvoorbeeld jou.
Er wordt het meeste gekeken naar de hoe effectief ze zijn op basis van de stock factor. Dus hoeveel stock je hebt ten opzichte van de export die je doet vanaf jouw verantwoordelijke locatie. Dit wordt dan ook gedaan aan de hand van de TSL die door de Operators wordt gezet. Aan de hand van je stock factor bepaal je de TSL, dit is steeds een wisselwerking met elkaar. De stock factor valideert of je een goede TSL hebt gezet, en daarop kunnen Operators worden aangesproken/ gecontroleerd. Je wilt niet te hoge of te lage buffers.

Gebeurt dit voor alle Operators samen, of de hele scope van een Operator?
Nee, je kijkt hier per locatie naar aangezien dit per locatie kan verschillen.

En is dit dan ook dezelfde target voor de Equipment Flow Analysten? Zij zetten namelijk zelf geen TSL?
Zij worden wel ook beoordeeld op hoe goed ze het doen aan de hand van de stock factor, maar deze zetten ze inderdaad niet zelf. Zij krijgen een stock factor vanuit het hoofdkantoor in Kopenhagen. Die bepalen de hoeveelheid beschikbare equipment voor de verantwoordelijke scope van de Analyst.

Zij worden ook beoordeeld op de utilization van een boot. Dus hoe vol zit de boot waar ze verantwoordelijk voor zijn. Hoeveel containers zijn hierop geladen.

Hebben deze groepen wel dezelfde interest in het systeem?
Ja, ze maken alle twee op dezelfde manier gebruik van het systeem. Je kan stellen dat hun interesse in het systeem is dat het hun werk niet alleen gemakkelijker zal maken aangezien het geautomatiseerd gaat worden maar ook dat het de uitkomst van hun werk beter zal maken.

D.2. Equipment Flow Analyst 1

Questions about the period before using the PLP system

How did the system come to your attention?
Antwoord op high level, nu moet ik gokken. Denk dat de oorsprong ergens in 2020 was, door COVID heeft het een tijdje stil gelegen. Er is toen der tijd een workshop geweest in Kopenhagen waar ik heen ben geweest samen met een andere collega waarin PLP gebracht werd. We hebben ook een training sessie gehad om het in ons gebied, Noord Europa uit te rollen. Dat hebben we ook gedaan.

Dus jij was eigenlijk de aangewezen persoon om dit verder uit te rollen?
Ja, ik was de SMI van PLP. Toen kwam COVID en toen is eigenlijk alles een beetje in de ijskast gezet. Nu sinds een maand of vier is het weer opgepikt, omdat het bedrijf er toch een hoop geld in heeft geinvesteerd wat toch terug verdient moet worden.

En dan het terugverdien model is eigenlijk containers van A naar B en naar de plaats waar we ze echt nodig hebben verplaatsen, waar ze gelijk inzetbaar zijn.

Voelde de trainingen die je toen in Kopenhagen hebt gehad als genoeg om het systeem echt onder de knie te krijgen en ermee aan het werk te gaan?
Ja en nee. Ik denk dat 2020 tot nu, dat er zoveel veranderingen zijn geweest, zowel qua process maar ook qua werknemers. De helft van het personeel is allemaal nieuw.
En als we alleen kijken van bijvoorbeeld 2020 tot 2022, corona even buiten becshouwing gelaten, zou je dan hebben gedacht na de training dat je met een positief gevoel naar buiten liep en dacht ik kan met het systeem werken of zou je nog steeds geen idee hebben waar je moest beginnen?
Ja, op een paar dingetjes na. Dat is omdat de tool op pool level plant en het overland transport zit er nog niet in. Maar op het moment dat dat losgelaten wordt dan zou het wel wat.
Dacht je dat toen ook meteen na die training?
Ja. Maar ook omdat het plant op pool level en niet op locatie level. We zien containers op de ene locatiie

binnen komen en een dag later op de andere locatie weg gaan, maar dat ga je niet voor elkaar krijgen.

Questions related to the use of the PLP system

In what way are you using the PLP system? Je hebt het net al wel een beetje laten zien, maar jij gebruikt het systeem eigenlijk wel echt zoals het bedoelt is toch?
Alleen ocean side, dus de boten. **Maar dat is ook waar jij verantwoordelijk voor bent toch?**
Ja. En om ook de intercoastal planning te beschermen. Dat zijn de containers die wij binnen ons gebied per boot van A naar B brengen. Rotterdam Gothernborg als voorbeeld en Felixtowe Bremerhaven. Dat zijn eigenlijk surplus locaties naar defecit en die restricties hebben wij zo PLP gezet zodat die beschermd zijn.
Maar hoezo heb je dat er dan zo ingezet? Houdt het systeem geen rekening met surplus of defecit?
Zou wel zo moeten zijn, maar PLP kijkt naar TSL. En als de stock binnen de TSL is en de projectie ook dan zal die niets plannen. En soms wil ik dat die wel plant, en dan kan je hem een beetje helpen.
Maar in principe zou die dit ook moeten plannen, moet dan niet de TSL worden aangepast?
Ja en nee. Het verhogen van de TSL is eigenlijk het creeeren van een bufferstock en dat willen we ook niet.

For how long have been you using the system already? Ik neem aan sinds 2020 dan met een dip van corona dan?
Ja, klopt met een dip van 3 jaar ongeveer. Actief weer echt de laatste 3-4 maanden.

Are you the only one from your team that is using the system?
Binnen flow gebruikt iedereen het, over heel de wereld.
Dus binnen het flow team werkt het gebruik van het systeem in principe?
Ja.

Questions related to the perspective on the system

What are your general thoughts about the PLP system?
Ten eerste het overland transport moet in het systeem geactiveerd worden, dat is ook wat wij met de jongesn van het ROCK platform besproken hebben. En er moet een tijd komen dat er ook naar locatie level planning gekeken gaat worden, want dat maakt het nog accurater.
Dus eigenlijk het systeem werkt wel goed in principe, maar er zijn nog fine tune dingen nodig zodat echt het hele bedrijf het kan gaan gebruiken
Ja, en wij doen nog steeds een hoop screenprintjes sturen naar de IT guys.
Dus het is een goed systeem met net iets teveel bugs?
Ja, nou ja kinderziektes

Do you feel like using the PLP system is saving you time, compared to a workflow without the PLP system?
Nog niet, maar dat is wel een puntje op de wishlist.
En hoezo heb je dat nu nog niet?
Dat is niet door het systeem, of het idee achter het systeem. Maar dat is omdat we nog niet de juiste restricties in het systeem hebben gezet en daarom dat er echt nog een check nodig is.

What additional values do you see in using the PLP system compared to a workflow without PLP?
Nee, het enige dat je wel af een toe een planning ziet dat nog niet eerder gedaan is. **Zet je dat dan positief aan het denken?**
Ja, dan ga je toch denken van waarom doet het systeem het, en de logica erachter. En dan denk je van ja er zit toch wel iets in. Alleen wat ik je net liet zien, PLP kijkt natuurlijk 2-3 maanden vooruit, wat wij niet doen. Wij gaan max 6 weken vooruit. **Dat ga je in de toekomst ook niet doen?**
Nee, want het is shipping, er veranderd zoveel, kijk naar de Rode Zee. **Maar heb je dan het idee van waarom doet het systeem dat, dat is eigenlijk niet nodig zover vooruit kijken?**

Nee eigenlijk is het wel goed, omdat je nu een veel betere projectie hebt qua stock verloop wereldwijd.
Maar ook al kijk je er niet naar, het is wel positief?
Ja, omdat, stel je voor we hebben dit niet en je kijkt naar hoe we vroeger werkten. Stel je voor Azie is super defecit. Wij deden de planning 6 weken vooruit, er zit dan 3 weken vaartijd bij. Maar als je toendertijd in de stockprojectie in Azie keek, hadden ze na 12 weken geen stock meer. En dat heb je nu niet meer, het geeft voor hun een veel betere projectie. En ook, het moment dat je nu onder je target komt, en de klanten proberen te boeken, dan zegt het systeem eigenlijk al, niet accepteren want er is geen equipment.

Do you feel any pressure from a hierarchical point of view of using the PLP system?
Nee, daarvoor ben ik hier te lang denk ik. Heb ook niet het idee dat andere mensen die zo ervaren.

Was it easy to adopt the system in your previous workflow?
Nee moeite niet, in het begin wel. Het wordt steeds makkelijker gemaakt natuurlijk door de IT jognens. En als ik terug ga naar 2020, was het meer gebasseerd op Excel files en Data bases, en nu is het natuurlijk een onderdeel van ROCK. En het werkt super simpel nu.

Now that you are working with the system, are you still content with the design of the system? Design bedoel ik dan vooral hoe het is opgezet, maar als ik het goed begrijp zijn dat dus het plannen op site nivea en het plannen land inwaards.
Ja dat zou er echt bij moeten wat mij betreft.

Zijn er nog andere dingen die je kwijt wilt over het systeem?
Nee niet echt, denk wel dat als iedereen wereldwijd binnen equipment ermee gaat werken, dat het wel een hoop kan gaan doen.
Maar voor flow werkt eigenlijk iedereen er al mee?
Ja, althans we hebben restricties gezet. Maar restricties vullen geen boot natuurlijk.
Dat is waar, maar heb je het idee dat mensen restricties zetten om het maar te zetten en het niet echt gebruiken?
Nee, mensen zetten wel echt serieuze restricties. **En heb je misschien het idee dat mensen binnen flow, jullie plannen natuurlijk meer van port naar port, dat het ook gewoon makkelijker is om het systeem te gebruiken? Dat de equipment operators het systeem niet gebruiken omdat een deel van hun werk gewoon niet in het system zit of kan?**
Nee, maar de bedoeling is wel dat dat gaat komen.
Maar denk je dat dat is waarom het nu niet zo is?
Ja. En ik denk ook dat het zetten van restricties voor main linen is heel wat anders dan voor alle overland positionings, want dat is denk ik 20x zoveel per barge en wat die barge kan laden en alles.

D.3. Equipment Flow Analyst 2

Questions about the period before using the PLP system

How did the system come to your attention? Was it just that you had a presentation or something about it, or did your manager tell you for example?
Let's take one step back. PLP belongs to an application called ROCK, it's a part of that. Before rock came into existence, we had a system called Region Box which was used globally by Equipment Flow planners to plan their movement of empty containers. Then Region Box was maintained for us by IBM. And it was very expensive. Obviously, because they were hiring staff for our requirements, we hired a team of our own developers and we designed a ROCK based on Region Box but with improvements which we wanted. So that's how ROCK came into being about two years after the existence of ROCK, PLP came into existence.

So when ROCK was originally designed, there was a dream. I'll use dream as a word because we are talking about long back in 2015, 2016. Because it was in the planning phase for a couple of years even before that. At that point in time we were not really having that much advancement technologically. But it was a dream that at some point this system should be able to plan on itself. The job that an equipment planner is doing, so it was always there and as soon as we saw that ROCK was a bit more stable, PLP was then let's say it was all always designed, but it had not gone live and then then we went live with it

in like if I'm not wrong, in September 2018, that's what my memory tells me.
And if we have a more detailed look at how the system came to your attention. Was it just an overall announcement? No, it was because I was already working on Region Box. So because I was already working on Region box, I was the better tester for ROCK and then I was the better tester for PLP. So I always knew that PLP was going to happen even before it existed.

Did you have any training in working with the system, before using it?
Yeah, I was a tester. The system was on a production platform. So the testing was mostly done there before we actually went live even with ROCK as a whole. So when we were doing the testing, it was just given to us on the production level and it was not really sending data back to Region Box but it was capturing what we were doing in Region Box at that point in time. At that testing phase.

And when it was decided that we have managed to repair a lot of the bugs that we found and we can go live with it. There was a global program for training a very extensive one. It was a multiple-day workshop across the globe. I was situated in the Dubai office at that time and so anybody who was going to use ROCK in the whole of WCA had to come to Dubai for a three-day three or four-day training, a very extensive one.
And did you participate in one of those trainings yourself as well? And do you think that those were extensive enough even though there were three days, but do you think without the previous knowledge you already had, you would say OK now I can do work with the system or at least know enough to start working a bit?
Yes, I might say very personally, I had that slight advantage because I had tested. But if I have to ignore the fact that I had seen how the screen looks or whatever the workshop was extensive in terms of not only the theory or the background, but we actually had to bring our laptops to the workshop and we had to do every exercise was discussed theoretically and then we were made to do it practically. So everybody had hands-on experience before they left the workshop.

Questions related to the use of the PLP system

In what way are you currently using the PLP system?
So the whole point of PLP was that we'd want to try and automate the process as much as possible. When we did not have PLP the way it used to be was that I had to manually go and create every plan that I had to execute. Now PLP does that for me and not only does it just do the standard plans.

But it sometimes also triggers a thought process because it will plan something from point A to point B, which I would have never planned and then it is it. It also depends on the user who looks at it, but it is information that we can even probably move on this leg if possible and stuff like that.
And in what way are you incorporating it into your workflow?
I try to incorporate it in a way that I try to allow it to plan as much as possible so that I don't have to manually do all these things and I only tweak down to the number.
But that's also the possibility there is with that you have to accept and confirm the suggestion it made?
Yes. So right now there we have already progressed to a point where we are having automatic approval of the OTT, but we have still held back a part of the process where we want to manually check before we allow the system to approve without a manual check. The reason for that has nothing to do with PLP, it is that the process that we have outside the system is not mature enough. So, we don't have the ability right now for ROCK to speak without error to let's say capture it. Or to the birding tool. So if GSIS is incorrectly updated and if the hub planner knows that the vessel is actually not going to berth as per GSIS. Right now there is nothing to indicate the same to PLP, it's going to trust GSIS data and if it is incorrect, it's going to have incorrect planning.
Because that is not updated that frequently? That they can be changed?
Actually, as per the process, they should be doing it, but then at the end of the day it's a manual process.
And PLP is taking that as an input?
Yes, it is the final truth. So what is happening is it is considering the date in GSIS as the actual date and then it is planning. But I as a human being outside the system might know some things that are not necessarily there in the system and hence we have held back on the total automation of the process right.

When PLP was launched, the auto-approval was also not there, but I always hoped we would reach that

stage and I'm glad it happened during my lifetime.
Oh, I thought that it was always necessary for a planner to accept the suggestion that PLP makes.
I leave it as it is, it gets automatically approved. In the past, we had held back that option, though the system was able to do it even before we said don't make it live because the process outside the system was not mature enough. Now we have a much more mature process where we are able to allow for the system to automatically approve after a certain time so that even if we miss approving it, the boxes can get included in the load list because that was one of the biggest danger we used to face in the past.
But do you think that's still working even though as you said before, it's not always updated with the latest information that's not in GSIS?
So the scenarios where the data in GSIS or caption not being correct are only exceptions. That's not the standard process. Those are exceptions and exceptions will always happen, doesn't matter how much automation or digitization we do. So it is only when the vessel is very delayed or there has been a change in the rotation and maybe the user is busy with something else and there's a time lapse between them actually going and updating the system and maybe I need to take a certain decision before the system is updated. So in that case the manual intervention does really help.
And I know from previous interviews that you can set your own restrictions for PLP so you can tweak it to what you think is the best. How are you using that?
I used to use this sentence whenever I started training people first on PLP. I used to say think of PLP as your pet. It will behave the way you train it. OK, if you don't tell it anything, it will do whatever it wants. Then you should not grumble that it's not behaving the way you want. It's as simple as that. So I think that is a very good comparison because when we tell PLP not to plan beyond a certain quantity or we tell it not to plan 20s plan, only 40s don't plan reefers or plan only reefers once we do that, we really don't have to worry because unless I go and change that restriction, it will continue doing it week after week every voyage. Without deviation, so the chance of a human error of me missing something, or forgetting something is very minimal once I have put the restriction.

So restrictions do help in the way PLP plans the things which are outside the system, for example, on the AES, we know that more than 500 to 645 feet will create a storage issue. But there's no way any cap sheet or any boarding tool or anything will ever give this information. Even the storage planner knows this from their experience. The only way I can make sure I don't plan more than that quantity of 45ft is either I do every week a manual check, or I just put a restriction saying don't. Yeah in PLP saying no, don't plan more than 500 boxes of 45 feet and it will still fill the vessel but it will make sure it doesn't plan that specific size type more than what I have restricted.
So for you, you feel like the restrictions and how they are implemented in or designed in the system is really helpful.
It is actually very important to have that. Otherwise, without that, the system will go berserk. It will just plan whatever it wants and it might not necessarily be what we want as a result of that planning. So restrictions are very important.

Have you been using the system since it went live, or also just sometimes when you would say, I can't use it?
No, every day it is. It's it's like the basic application that I'd use throughout my working hours every day without fail.

Are you the only one from your team that is using the system?
No. Anybody who works for equipment doesn't even have to be the Flow team. Anybody who works for equipment has to use this system.
But I mean like already using, because I'm also in the equipment team and I know only some people are using the system or are making use of its suggestions. like I know from my colleagues, they are not using or looking at the suggestions the system is making because they don't think the system is correct.
I will clarify that when I said anybody who works with equipment, I meant anybody at the OCL country area levels. These are all execution people. We are not the strategy or the planners. We are the execution people. So anybody who is hired to execute equipment plans, it doesn't matter whether it is ocean legs, it's coastal legs or inland. They will need to use ROCK day in and day out. It's our primary application of usage.
But there is a different right, in using ROCK and using the PLP system that's integrated in ROCK.
So for inland, I know that a lot of people do not like to use PLP, but it's because PLP is not as mature

on the inland part of business as it is on the ocean part. Also, I think it is also a person's mentality. So just like me, there are other people who have been using ROCK from the day it was launched and they are used to the system. What existed before that was Region Box, which was a purely manual one. Somehow they feel more comfortable to manually control the plans. There will be a few people globally who should be using PLP but are not. They might be doing it either because the geography they handle is a very erratic one, very volatile, very dynamic, so it requires so many changes that they prefer to do the manual way rather than allow PLP, or they are just not very comfortable in allowing a system to plan for them and they find it easier to just update the system themselves.

Questions related to the perspective on the system

What are your general thoughts about the PLP system?
I think it is at a very good stage right now. We have had so many improvements since it was launched, so I'm happy with the progress. I think generally speaking a lot of users should have positive reviews about PLP. It's not that it is perfect. There are a lot of things which we can do better, but we are not able to do it either because digitisation is not as progressed or something else needs to happen before we can initiate some of the improvements that we have.

But we do have a forum for this which meets on a fortnightly basis and ideas are shared and then we have a brainstorming. So there already is a very good platform available for anybody who has any suggestions or a question on what we can do better. For me, I feel there has been a much-increased enthusiasm. In making sure that we can get the most out of PLP.

Because when it was launched, people, especially people who had moved to ROCK from the previous one, were very apprehensive. They did not trust the system. But luckily or unluckily, we have had changes in staff globally. There's a lot of people who were using Region Box have moved on to other jobs and a lot of new people who have come in have never known anything other other than what is happening now. So for them this is how the system works. And it has actually turned out to be for the good because they come with an open mind and they accept the situation. The only thing we get out of that is improvements because they want to know if we can do something faster, easier or something more automatic or something like that. So it's actually good. I don't see a downside to this on the future in the future timeline. Worst case scenario, it doesn't improve. That's the worst-case scenario. Like it doesn't improve.
Do you see the system as a system with PLP and a system as ROCK, or do you see it really combined?
For me, it's one thing it's the same thing, so I sometimes also have this difficulty right as a person who is not very of a very technical end of mind. I am from a generation which saw computers being invented. OK, so sometimes what happens is when I'm speaking to some of the developers and trying to say, OK, why is the system doing this and they say, but this is not PLP. And for me it's like I don't care for me, it's ROCK. So yeah, I am not able to differentiate and frankly I don't care. I don't want to differentiate between PLP and ROCK because for me, PLP is, I think it's a part of ROCK which should make rock better for me. Ultimately the end output from ROCK is far more important than PLP as on its own. So PLP may be at its best. But if it is not having a positive impact on ROCK as an application, it is of very little use to me very frankly.

Do you feel like using the PLP system is saving you time, compared to a workflow without the PLP system?
Yes, but I come at this one purely from the perspective of a person who has used other systems for doing the same job. So I come at this question as a person who has used applications which are other than PLP. So I know how long it used to take when we didn't have PLP. So a person who's started using ROCK after PLP has already been live might not know the difference, so for them it's not saving them any time because they already always use the system, when PLP was there.
that taken up a lot of time?
Yes, not only make them amend them on a daily basis and keep an eye to make sure that I'm not missing out on something, yeah.

What additional values do you see in using the PLP system compared to a workflow without PLP? Or is it mainly saving time?
No. As I said, sometimes PLP suggests a plan, which I would have probably not thought of. I won't say

that all of them are executable. Some of them are pure nonsense, but it is food for thought because even if I have to say out of 100 suggestions, one is workable, I think it's still worth it. As a human mind, we think from our past experiences. So if I have never tried something I would not know, I can do that unless I am working on a project or something. Maybe I will not even realise that there is something outside the box which is possible. But PLP is suggesting things which may not be possible, but if there is even one plan which is possible and it gives me food for thought, I think it's it's a very good deal.

Do you feel any pressure from a hierarchical point of view of using the PLP system?
For me, yeah. For me, when we launched it, there was a lot of resistance from the colleagues who had to transition from the manual updates to this, and they kept on complaining about every little thing till they became comfortable with it, because for them it was a learning process and I had to be very strict with them and say, no, you can't you have to use PLP, you have to use PLP.
And do you feel like someone is also above you saying, OK you should use it or you are forced to say it like that?
No, no, no. It was also a directive right from centre because we have invested a lot in this transformation and it could be a better transformation. So there is very little reason other than comfort level to say that we don't want to use it. But as I said, this was a very old thing. I don't think anybody who has used ROCK after PLP launched would even pause to think if they should use it or not.

Now that you are working with the system, are you still content with the design of the system?
Yes, yes, we are. I think we are already doing that on a very regular basis. As I told you, we have these brainstorming sessions every fortnight and they have been useful and it can be something as simple as the colour of the screen or the font or something as more complicated as having some automatic calculations based on input from another system which was never linked earlier. So for example, the capacity information was not linked earlier. That's a very recent development.

Yeah, so, this is something which has happened very recently. So it is developing and our business has changed a lot. So the way we could get away with doing equipment planning in the past a decade ago, we can't function like that. So any person who is very headstrong and doesn't want to use PLP is just making things difficult for themselves. I don't think there is anybody like that is left anymore as far as I know. But you never know. I don't know every person using ROCK globally.

But I surely hope there is no nobody left like that. Or like, let's say five years ago till about five years ago, I knew of people who genuinely hated using the system. But I think it was all in the mind it was something like it was a big change. They didn't want to. They were so used to Yeah.
And how come actually that you weren't thinking like that?
So for me, it was very important that we should have digitization, transformation and automation because if the company's strategy overall for our business is that then just equipment not being a part of that is foolishness to expect that we can get anything out of it. So for me, it was good and I actually I'm proud that I think ROCK has the least amount of bugs at this point in time when I compare it with the applications which capacity colleagues or marine colleagues have to use. We we have a much more straightforward system less complicated, and more user-friendly for me. I'm not very big on the formulas and the backend calculations I'm all about end use. So for me, if I'm not comfortable using a certain screen, a certain button on the screen then I will say that. I think the only way we can encourage more and more people to use it is to make it as simple as possible.

The simpler it is, the easier it is for them to adapt to the new thing. They will accept it more easily if we just make it complicated and you know you have to. It's like going down 3 tunnels to find the information, then it is no longer encouraging to the end user to even want to switch from something else to this system.

D.4. Middle line representatives

Strategic viewpoint

Who was giving the starting call for developing the system?
It was a strategic initiative. There was a drive to optimise operations and save costs. There were a few initiatives around equipment leading up to the decision of this. Benefits from automation were looked at. Learnings from pilot around optimisation which developed into a strategic initiative. The call was given out of strategic high level.

Was there a need from an operational viewpoint for a system like this?
No, which is also typical for these types of initiatives. These are not bottom-up designed because of differences in how to operate the system.

Was this plan lying on the shelf for a long time already before it went into production?
Some years before but not too long. There was a collaboration with IBM some years before on automation, so the idea of automation was there for a longer time, but not all too long.

What was expected that the system would optimise?
The main driver for developing the system has always been reducing costs and reducing the amount of equipment necessary to cover the bookings. The overall perspective of automation has always been that with more automated processes, there would also be an opportunity to reduce the efforts necessary to do manual planning.

Shift from letting people move containers in a simple way to have a logic that defines why we need to move containers in a certain direction and how much we need to move. To remove a lot of the manual work that goes into the current system, which was not a scalable solution previously. Removing the reliance on people to go into the system and decide how much they want to move. PLP was designed to be demand-driven. Was to automate and reduce costs

Is the current system also optimizing this?
The goal is not achieved since the system is not efficient there is something wrong because users are not using it. There has not been developed a truly different process. At the moment there is still a manual process and an automated one next to each other. It is a combination of gaps in the system and how it is developed and gaps in the business implementation. But important to know that it is not a situation where you can point your finger at one of the problems.

Currently, there is a mismatch in how the system's development is taking place versus the majority of the organization. There is a different level of maturity and handshakes in the commercial part of the organization that we want this demand and the system's protecting this demand, those are not matched. So people are not using the automatic plans in PLP because it does not match to the demand people are using in their region. There is a mismatch in what the system says and what the rest of the organization says. Not all the forecasts used in the organization are implemented in ROCK.

Another mismatch in the system and the organization is that the world we are operating in isnt static. This becomes clear in the ship's capacities. However, the inputs in the system in ROCK are correct, it just isn't live enough.

Were there also insights into how the system would be implemented in the business or was there only an eye for the development of the system?
When the first version of PLP was rolled out there was a big effort put into the transformation of the business and the implementation. People were dedicated to this. This resulted in actually changing the process in some of the regions which led to an increase in the adoption. Europe was leading in this, they are more mature in using systems and have more standardized processes compared to other regions. This was all pre-COVID.

What is the current viewpoint of the management teams against the system
From a strategic viewpoint, there is less dialogue on the use of the system but more on the outcome of the system. Of course, because there is an investment in this system it is natural to use this system but not push for it. The focus is on where are the costs happening.

The management team has no preference in which system to use but is more looking at the output an operator and flow analyst gives. How to optimize their results. Looking at the most efficient way to supply all the demand questions of customers.

Design of the system

When the system was designed, was it only a strategic viewpoint or also operational?
There was input, there was engagement from different teams and different regions.

What were the main criteria for designing the system?
The main overarching criteria was to support the process of having the equipment to cover the bookings.

How are the restrictions you can set in the system designed and why are they designed like this?
Already at the design phase of the system, we knew that we did not have all the needed data and proper data sources for some of the critical processes. Therefore it was decided to give the operational planners the input rights because they are the experts in this. Hope and ambition that this would work, that they would give the system some direction to plan. There were talks with the planning departments about this approach but the question will always be if this had been enough. Meetings that you can have on forehand might be very different from the day-to-day business. When it went live became clear that it was too difficult for users of the system, but there have been meetings and input sessions about this approach, also with users from the operational level for sure. Also problem with all the interdependencies there are with all the regions and how this is influencing each other.

D.5. Equipment Operator 1

Knowledge on PLP system

Op wat voor manier heb je ooit over het systeem gehoord?
Gelijk toen ik begon al, de eerste week/ eerste twee weken, dat is nu zo ongeveer 2 jara geleden.

Van wie heb je dat toen gehoord?
Van mijn team genoten die om me heen werkten. Niet van het management niveau. Daar hoor je juist een andere mening over.

Would you say your current level of knowledge about the system would be enough to work with the system?
Ja

Heb je ooit een ander soort introdcutie in het systeem gehad, of alleen dit is het en het werkt niet?
Nee, de manager destijds heeft het wel uitgelegd. Maar eigenlijk geen training. Ik heb wel uitleg gekregen hoe het werkte, dat als ik er dingen (restricties) in zou willen zetten om het systeem te gebruiken hoe dat zou moeten.

Toen ik begon deed ik eigenlijk alleen de inlands. Maar toen ik begon werd ook al meteen gezegd, dat om het systeem voor de inlands te gebruiken wordt heel lastig, zeker op dat moment nog, in de tussentijd is er vast nog wel wat veranderd natuurlijk. Dus kwam je er al wel achter dat het beter was om het systeem stil te zetten, want anders kreeg je hele gekke dingen. En op Rotterdam kijk je elke dag, maar op je inlands niet altijd naar elk depot elke dag. Dus dan kom je soms dingen te laat tegen, dat er al een tijdje een suggestie instaat van PLP wat eigenlijk nooit gaat gebeuren. Dus dat was in het begin vooral.

Use of PLP system

Have you ever tried using the PLP system? What were your experiences?
Ja, want het eventuele voordeel wat eraan zit is dat je een planning verder vooruit aan het systeem vooruit kan laten, dat scheelt mij werk. Dan hoef ik niet over 6 weken vooruit te kijken, dat vertrouw je aan het systeem toe.
Doe je dat nu wel eens, 6 weken vooruit kijken?
Ja, want je met je planning zo ver vooruit erin zetten. Dat moet je nu zelf doen. Wanneer je dat aan het systeem zou overlaten zou je dat niet meer hoeven te doen en pas naarmate je dichterbij het eind van die 6 weken komt zelf weer naar die planning moeten kijken.

Dus daar zit wel een voordeel aan, en dat heb ik ook wel willen gebruiken. Maar op de een of andere

manier, wanneer je dit wilt gebruiken is er toch altijd nog een route open die niet goed beschreven is dat alles weer werd weggepland naar een ander depot.
Dus er zijn eigenlijk nog teveel fouten in om het goed te gaan gebruiken?
Ja fouten, misschien is het ook een keer het punten dat je zelf een keer alle restricties moet opschonen en erin moet zetten. Maar als je dat voor alles moet doen is dat best wel een werkje. Maar misschien dat als je dat zou doen dat het dan wel goed moet komen.
Maar je hebt dus niet het gevoel nu dat het systeem je zo veel tijd zou besparen dat je het waard vindt om een keer tijd te blokken om die restricties op te schonen?
Nee, dat gevoel heb ik niet, dat is echt puur gevoel en niet echt ergens opgebaseerd.
Heb je om je heen succesverhalen dat je hoort dat het bijvoorbeeld heel veel tijd bespaart?
Nee dat heb ik ook niet, ik zie vooral juist alleen de negatieve dingen. Dan denk je daar ga ik niet aan beginnen.

Perspectives on PLP system

What are your general thoughts on the PLP system? Is dat vooral slecht, of zie je ergens het nut er wel ook nog van in?
Ik zie het nut er wel vanaf, zie wel het doel van het systeem. Maar je ziet nu nog hele gekke dingen gepland worden. Moet wel toegeven dat is vooral Rotterdam met de deep sea. Rotterdam heeft zoveel connecties overal naartoe dat je hele gekke dingen tegenkomt, dat kwamen we vandaag ook tegen, planningen niet onrealistisch zijn. Dat komt waarschijnlijk omdat de capaciteits planning, of hoe dat erin is gezet niet goed is. Doordat sommige dingen wel goed zijn gezet en sommige dingen niet zie je… Vanaf Engeland voeren we normaal altijd af, maar op de een of andere manier heeft het systeem een route voor volgende week gevonden dat we daar juist naar toe gaan voeren, omdat er dan daar een andere connectie naar weet niet waar is. Terwijl je weet dat dat niet gaat gebeuren.
Dus je ziet wel het nut van het systeem maar hoe die het nu plant is niet goed.
Ja. Daar zorgen we zelf ook wel voor omdat het maar deels gebruikt wordt.
Dus dat zie je ook wel, dat dit aan jullie ligt en niet per se aan het technische deel van het systeem
Ja.
En wat zijn je gedachten over het gebruik van de restricties? Zie je dat positief of zou het liever zien dat dit gewoon standaard in het systeem zit?
Je komt er denk ik niet onderuit. Het lastige is dat er heel veel verschillende mensen het bij moeten houden, dus het ligt niet alleen bij jezelf.
Zie je daarin wel dat je een samenwerking met die mensen kan hebben?
Jawel, maar en hoeft meer een iemand net per ongeluk een fout te maken wat je meteen terugziet in de planning.
Dus je ziet het wel als een erg kwetsbaar systeem?
Ja, dat gevoel heb ik in ieder geval wel.

Do you see the additional value that PLP would have when implemented in the current workflow? Of zou je dat nu niet kunnen zeggen?
Als het systeem goed werkt zou je wellicht kunnen zeggen dat een systeem beter plant dan een persoon. Maar dat weet ik niet, dat durf ik nu niet te zeggen.

Do you feel like there is some pressure from the company, e.g. manager, on using the system?
Nee, het wordt wel geopperd, maar je wordt niet hard een kant op geduwt. Het gaat meer om de output die je levert dan de manier waarop je daarop bent gekomen.

D.6. Equipment Operator 2

Knowledge on PLP system

Have you ever heard about the PLP system before? And mostly in what way?
In the beginning, when I started working here, about two years ago they did show me. Because on the onboarding I was asking why are there automatically some OTT orders. And they told me that that was the PLP system. And I have to say the opinions I have heard about the elder colleagues about the system are not positive.
And was there prior to that, some presentation or training? Or was this your first encounter with the system?
That was my first encounter with the system. To be honest, in the onboarding process, the PLP system is really not their focus, to have us work with it.

And after the onboarding, was there some presentation or training about it?
Afterwards, I did look it up myself. There is a presentation with slides available where they explain how is it calculated and what is the purpose of the company portal. Out of my own curiosity, I had a look at it. But I have to say that the picture that they are showing is quite different from the reality.
So you wouldn't say that after looking at the presentation yourself you can say that you are confident enough to use the system?
No, not at all.
And was there any other training or presentation you had in the meantime?
No. That presentation so far was the only training sort of that I have been exposed to.
And everyone was okay with you not having a training?
No, what I said during the onboarding of my work buddy who was onboarding me, he was not using that. And I have to say after a while I could also see that the system was not planning well.

Use of PLP system

Have you ever tried using the PLP system? What were your experiences?
Yes, we did. I have to say that the plans that the PLP system is planning for us, most of the time are only hindering our calculations. Sometimes it is planned from a deficit depot to a big order to supply one of the surplus depots. We know it is not going to happen, but then all of a sudden you see a stock drop and we don't know where it comes from and we have to look it up and then we see this order that is nonsense. And sometimes in my inland depot, it is planning something in the correct direction, from a surplus to a balanced depot. But then it is just not necessary because it is a balanced depot. And the number it is planning, it just plans 2 containers.
And do you see why the system is planning like that?
It does say to us that one of the functions in ROCK, where you can enter some document or file, helps the system to calculate it, but I feel like no one ever really did upload or adjust the right documents, at least not the people that I talked about it with.
And what are the roles of those people? Also Equipment Operators?
I don't think so, also other people in equipment because that is a bit more complex than we can do.

Perspectives on PLP system

What are your general thoughts on the PLP system? With the basic knowledge you have of the system. Do you see that the system could help you?
The main thing is that we should get people already more aware of the system by incorporating this system in their onboarding system. And not let them have the first impression of the system that the system does not work. To help it work better, we also need to know how to change the system. Because now people have not changed the input of the system and the database for really long, that is why it is out of date. And nobody is looking at why it is planning things like it is planning at the moment.
And with nobody you mean the equipment operators you are working together?
Yes, I don't think we ever check it.

Do you see the additional value that PLP would have when implemented in the current workflow?
I think it is a good reminder for us. Sometimes I let go of a surplus depot where not much is happening, I forget to check the cost sometimes, and check the stock with the booking. And that PLP system is actually a very good way. And also the deficit depot. Now I am using teams to set a reminder for myself every week that I need to plan supply. But if the system is actually working, that will be a good reminder. Then I don't have to use teams anymore.
And do you think the system will save you time?
Definitely. I don't have to make a plan myself, an order is already there. And, as I said a reminder is nice. As I am working on different countries sometimes you tend to forget the more stable depots, and this is a good reminder for us.

Do you know about the restrictions in the system and how they are used to plan?
Not really actually.

Do you feel like there is some pressure from the company, e.g. manager, on using the system?
No, I have to say, my manager mostly just let me do my job and more looks at the results.

Is there anything else you want to share about the system?
I actually think that it is quite a waste that we have this automatic system that is helping us with the planning, to do better optimisation, to work on other parts is not being promoted or used, or updated with the employees. And if possible I would like to use it.

D.7. Equipment Operator 3

Knowledge on PLP system

What was the first time you heard about the PLP system? En op wat voor manier ging dat?
Ik heb het een beetje gezocht in mijn mail, dat is eind 2018 geweest. Toen werd het geannounced, uitgerold en presentaties gegeven. Die presentaties heb ik allemaal gehad en die waren allemaal op kantoor, dat was nog voor Corona.
Door wie werden die presentaties gegeven?
Dat weet ik niet meer, dat was wel lokaal. Niet het idee en de herinnering dat daarvoor mensen uit Kopenhagen werden gestuurd. Ik kan wel zien dat de toenmalige equipment manager voor Duitsland de presentatie heeft geuplaod.
En had je toen een soort training of alleen een presentatie?
Een training is een groot woord, je krijgt meer mee van zo kan je het systeem gebruiken.
Had je het gevoel dat na deze training je kennis over het systeem voldoende was?
Ja zeker. Indien het systeem bruikbaar was, kon ik het gebruiken na de training.

Had je dan na de training al meteen door dat het systeem niet te gebruiken was voor jouw werkzaamheden?
Niet direct, want het is natuurlijk een nieuw systeem wat je kan gebruiken. Want er zijn natuurlijk ook momenten geweest dat PLP ons wel heeft geholpen. Want het systeem zorgt er natuurlijk voor dat je coorraad er nauwkeurig uit ziet. Op dit moment zijn er veel restricties gezet waardoor er niet goed wordt gepland door het systeem. Maar wanneer deze er niet zijn plant het systeem natuurlijk je voorraad leeg naar de locatie waar dit nodig is. En dat doet die natuurlijk weken vooruit erin zetten en ziet je stock verloop er nauwkeurig uit. Dit vermijdt ook veel discussies die we normaal hebben tijdens de wekelijkse meeting voor alle stock overzichten. En je kan dezelfde PLP orders ook gebruiken om aanpassingen te doen, als je bijvoorbeeld minder wilt.

Use of PLP system

Maar eigenlijk zijn je ideen over het systeem positief, wat is er dan gebeurd dat je het systeem nu niet meer gebruikt?
Punt is, hij laat niet alleen orders zien naar port locaties, maar ook hele onlogische orders. Zo geeft die bijvoorbeeld aan dat je een order van Venlo naar Amsterdam kan doen, maar er is geen verbinding hiertussen en ook geen operator die dat kan uitvoeren. Zo een optie kan je dan dichtgooien met een restrictie, maar wanneer je alle restricties voor onlogische orders erin zet blijft er maar heel weinig over om te plannen.
Dus eigenlijk de reden dat jij het niet meer gebruikt is omdat het teveel onlogische suggesties gaf?
Inderdaad. **Heb je het gevoel dat je dat had kunnen oplossen door de restricties anders te zetten?**
Je kan alleen met zo een systeem werken als iedereen er mee werkt. Dus er moet gewoon een verplichting zijn dat je er mee moet werken. Dan pas werken restricties en wordt het logischer voor iedereen.

En heb je het gevoel dat er niet een druk ligt vanuit andere teams om dit systeem wel te gaan gebruiken.
Nee dat is er niet geweest, ook niet na Corona. Om een voorbeeld te geven, jij geeft aan dat de flow analysten het systeem wel gebruiken. Met de flow analyst waar ik veel mee samenwerk heb ik afgesproken dat alle PLP suggesties die gaan over specials blindelings worden geannuleerd door beide. Ook al plant zij wel van port naar port, zij hebben ook liever dat deze order gecanceld worden.

En wat je ook hebt, stel PLP stelt voor om morgen 40 HC af te voeren, dan worden we uitgemaakt voor een clown door de barge operator. Die zeggen dan, dat kan alleen als we morgen plek hebben, anders zullen we ze de eerst volgende mogelijkheid dat we plek hebben ze afvoeren.

Dit kan je natuurlijk aanpassen als input voor het systeem, weet jij ook hoe dit moet?

Ja dat weet ik wel, maar dat doe ik niet. Zo wordt het niet gebruikt.
Want als je dat wel zou doen zou je wel betere planningen kunnen maken?
Niet direct, want bijvoorbeeld vorige week was APM2 gesloten, wat kan je dan met een restrictie eraan doen. Ga je dat dan met allemaal restricties aanpassen? Daarvoor is het systeem niet live genoeg voor om dat bij te houden.
Dus jij hebt vooral van, het werkte hiervoor al niet goed en als niet iedereen het gebruikt werkt het zeker niet?
Nee, dan werkt het zeker niet nee.

D.8. ROCK Platform owner

General information about ROCK

There is a platform called ROCK, and PLP is a component of ROCK. There are three people responsible for the ROCK platform. There are different platforms for everything, there is ROCK which manages equipment. There is a different platform that manages capacity, that is not in the same platform. There is another platform for pricing. When Maerk makes an offer to a customer, there needs to be a price, capacity and equipment. If any of these three fails Maersk will not be able to make an offer. All of these responsible platforms have been developed individually, they are starting to sinc up. Since the last three years they are running the company, before more was done in Excel and not in the cloud. ROCK has developed over the last 2/1,5 years, investment to develop ROCK was possible. The equipment teams you have been talked to are responsible for managing the business week in and week out, and the teams that support ROCK are responsible for supporting the business.

How does the repositioning of equipment work?

There are contract customers and spot bookings possible. We want to segregate the customers to the ones who we can build a contract with and the transactional customers for spot or free sail bookings. We assume the contract customers know how much they will ship every week and for what rate, this is when Maerk enters the flow of the customers.

It is important for Maersk to have contract customers because this gives a guarantee of shipping. From there the cycle of repositioning starts. As an Equipment Operator, you want to know how many containers you need to make available in your pool and how many of them are going to come naturally, because of imports from other regions. This is one example. Some of these imports are predictable because of the contracts customers have. However, you know the contracts are not 100% correct.

Different teams/regions around the world are operating with different modus operandi, there is one general way this is arranged: The commercial team put in a forecast every week called WCR, a weekly commercial review, in one of the PowerBI dashboards. Then regions have their own calculations of the numbers, but the general way this is done: X number of containers broken down into 20ft and 40ft. Calculate the number of containers for a specific type. Then each of the geographies for which the forecast has been done is broken down into the pool level. This is done by the Equipment Flow Analysts and gives an idea of how many containers they need to arrange per pool. Calculations are done in Excel. The next step for the equipment team is to look at how many they get through inputs. Look if a pool is a deficit or a surplus location. The Equipment Operator needs to make plans to organize the equipment for the responsible region, depending on surplus or deficit. This is done via an OTT, a positioning order.

An OTT in PLP

PLP is a system that is striving to automate the OTT orders, it is an optimizer for this which has all the inputs to create a repositioning plan and order. The need for PLP comes from the complexity of planning an empty container. It is not always that an empty container just needs to go from Rotterdam to Utrecht, it also happens that a container has to move to another continent. With this planning, a lot of complexity is added to the planning which is too hard for an individual to take into account. This also comes from the global trade characteristics.

China is a natural exporter but not an importer, which is why it is always in need of empty containers to import. The regions surrounding China do not have a big enough volume to fulfil the demand of China. That is why you need to go looking more to the west to look for supply continents. This is how you end up in Europe as supply for China. The more west you go to supply China, the more complex the planning is going to be because it (the container) then has to go to multiple places, it does not start in Panama and go to China in one leg. For an operator to know all those complexities would be too much. They are just working in their geographical location and they do not know all the prices of the different legs a container would have to take. Too complex for one individual to know.

We want the planning to go through PLP, because in the long term, we believe that it is better to strengthen PLP and its capabilities than to expect people to make the right optimal planning. The question is how do you improve PLP?

If you look at an OTT creation in the current workflow, the Excel that has been made by a Flow Analysts is the starting point for an Equipment Operator to create an OTT? Please confirm with someone from the equipment team, I assume that this is the case. An Operator gets the Excel file from the Equipment Flow Analyst who breaks down the needed equipment per pool, this is the starting point for the operator to create an OTT. Different regions have different setups for this.

The general idea of planning: Something starts from the customer. To the commercial team. To another commercial team, like CX. Then to equipment. Sometimes this is how equipment want/need the information, sometimes it is needed for equipment to do their own calculations on top of this. Then an OTT is created to fulfill this demand

The commercial team don't operate at a pool level, they operate at a trade level, trade flow between Europe and Asia. The Equipment Operator is looking at site level. The trade level flow can be seen as the starting point of it all. However, this needs to be broken down into high granularity which the equipment team needs.

So the only thing that is the same is the starting point, the trade level flows, and the creation of an OTT to reposition equipment? Every equipment team is making OTTs, no matter how they get their information. This would not be a problem for PLP since this is only looking at OTT suggestions. For PLP what matters is that the demand should be correct, demand that is filled in in ROCK.

PLP is also looking at the TSL. If someone is maintaining a TSL of 400, this means that it is maintaining 400 more containers then there is a need for in the demand, this means that these containers will never arrive in China even though there is a demand for those containers in China. This ends up in the company buying more new containers, which would not be necessary since there are enough containers out there. However, these can not all be used since some pools/regions etc are keeping these as a buffer. TSL is also in ROCK, this is everywhere in the world, no matter how their workflow is arranged. This is set per region. There is also another team sitting in the centre which is dealing with central flow planning for all operational regions globally.

Are there teams who are negatively influenced by the current workflow, without PLP? It is mainly the company that is negatively influenced by not having PLP integrated since it is costing a lot of money to for example buy new containers, especially since this is not necessary. It will also save people, the flow operators, a lot of time.

Is this workflow often changing due to new implementations or other tools, or is this the first time the flow is optimized? PLP can be seen as the first system "breaking" into the flow, there were not really things changing to the flow, it has been the same for many years. There was never a time to automate this stuff. PLP has been there for years, we brought in a lot of focus this year. We start to save costs, which PLP is one possibility.

Once the PLP is integrated into the workflow, what else is changing? And is the tool replacing people? The only thing that is changing is that PLP is suggesting an OTT, for the rest nothing else is changing when this is implemented. For now, it is just a suggestion tool. The rest of the flow will more or less stay the same. It is also not replacing people at all, this should also not be the goal of the company. The reason to focus on automation is because it is just too complex for a human being to plan a container across continents.

Do you think that for a correct use of the system it should be implemented all at once? No, have to stage it. Also, the people who are going to use the system have years of experience and are doing things in a certain way, you cant just expect them to do things differently. There are probably the most important people who can help you with the optimizing of PLP, you will need them.

D.9. PLP developer

D.9.1. Interview 1

What exactly is your role in the PLP system?
I've been implementing the actual code for the optimizer. The design of the system and so on was done by other people. My part was meant to implement and maybe say what is possible and what is not possible, more from the technical side. This was done back in 2018, since then there hasn't been much development. I've also been helping users with questions where needed, so also some user support. A business case from a technical side one year ago showed that there is still benefit if you manage to turn this around and use automation for business.

What where the intentions when the system was designed? Do you think you are able to answer this question?
I wasn't involved but it is clear to me what we want to do. We need to make containers available where they needed, so that is what you want to achieve. We tried to meet the demand as much as possible with the lowest cost. And the intentions is how good can we cover the demand and decrease the costs. I wasn't much involved in the design of the system. I'm now more involved in this strategy of turning it around to help users.

Where you given any criteria when you started making the system?
The criteria was to reduce cost and the target stock level, but on a very low level.
So for the rest you were given a lot of freedom?
Also on the technical side the engineering manager was very involved in designing the system. And I was more or less just making it.

Which part of the planning is the algorithm trying to optimize?
To have containers distributed correctly and to lower the costs. And the main cost that PLP can influence is the crane cost of loading and discharging. But there are also some other components like storage costs, those are minor to the crane costs.

What was taken as the scope that the system would optimize?
It was on the operational cost side. And we have meetings about the incentives for meeting the targets.

How is the algorithm coming to a suggestion?
We can formulate it as an optimization problem. There is a current state of containers where they are at the stocks, the import and export forecast, and the shipping network. It will be some kind of flow problem. There are X things coming into the network in different ways and then it can flow. But there are different ways they could flow trough the network and get out of the network for export. For the different flows there are different costs. And there are incentives. There is a minimum stock level that we want to be above this minimum in order to cover the exports. The system is furthermore also taking some uncertainties into account and also some operational limitations.
And in the end it is making the suggestion based on all these criteria.
Yeah, you formulate this optimzaiton problem, which is a flow problem, and then it is called the multi commodity flow problem because there are different types of containers. Then there is a mathematical formulation that is taking all the constraints and incentives into account. I will share the formulation to get an idea of how it works.

How are the restrictions users can set for suggestions implemented in the design of the system?
Users can change a lot of the values the system is using. It is not really the design of the system, it are the values that they can change.
And those values can restrict the algorithm to make suggestions?
Yes. The big thing is the crane capacity. We never had a way of sourcing those automatically. We need users to put in those values, but it is misused to prevent the PLP system to make suggestions.
And users were given the freedom to set these values because there were not known?
Yeah. Since the input data is not generally known, it is hard to manage because we cannot tell them.

The system is making suggestions on pool level right?
Yes. The original intention was to plan on pool level. But when we went in production in 2018 the feedback was that it was making unrealistic suggestions. For example, in Rotterdam, which is a big pool with several terminals, PLP was only looking at pool level. This resulted in a suggestion to discharge from one vessel calling at terminal 1, and loading on another vessel calling at a different time and different terminal. Most often they don't want to do because that would require them to move the contents again.

So then we change the model, so it also keeps track of the terminals where the vessel callings are. So that was an extension, but the intention was to plan on pool level. It did not switch to site level, only to the sites that are also used as a terminal.

What information exactly is PLP getting from ROCK and how is it using that information?
The operation is triggered from ROCK and all the data is prepared in the ROCK system. I'll share the manual that shows all the input the system is using from ROCK.

Transcript of teams conversation

What are your/your teams responsibilities, interest and targets as stakeholder participating in this system? This is a little bit tricky question for me because the separation of responsibilities has been unlear to me. There has been a conflict in my view of how responsibilities should be separated and how it works (or does not work) in practise. In my mind, the development team should find out what business needs from the system, decide specifications and build a system that works according to specifications. All of this is off course best done in an iterative manner until we reach a system that is functioning. Then we should participate in the work of clarifying user questions or investigate possible errors. The responsibility of making sure there is a working process on business side, to monitor the system is behaving as expected and bringing value should primarily lie outside of the development team, closer to business side. In reality I think this separation has not been clear or it has been in the hands of a single person (often the product owner) who clearly doesn't have enough capacity for it.

It seems correct to say our interest is to enable automation. For target I would say it is about bringing major operational saving as compared to the manual planning and in long term simplify the work flow of planners. I wouldn't express it as "correct optimization algorithm". We will never have a system that is 100% correct. The complexity of making the system more correct is always balanced against how much business value that would bring.

D.9.2. Interview 2

Most of the time users are correct that the suggestion by the system is not making any sense. But this is mainly because of wrong input data in the system. Users can see where the incorrect input is given in the system, however, this is very hard to find in ROCK by users. This can be a result of the constraints users set themselves in the system.

How is the input implemented in the system? Can users change all the input in the system?
They can change a lot of the input in ROCK but not all of it. This is because we don't have all the data that is needed as input. This can be changed in the "Masterdata" screen in ROCK. Even for me it is hard to find, this is also what users should do in the system. It is a complex system and hard to find for users. Often it is the case that a user is asking why PLP is not planning between two locations and the reason seems that the users themselves have set the move limit to 0, so PLP can not suggest anything. Users know what they want, but they don't know why it is not happening.

Is all information users need to check the input in the Masterdata screen?
Not everything, there are also other screens used in ROCK to constrain the input the system is using.
The input data users need to adjust is in different screens/places in ROCK?
Yes, this is in different screens. You can change a lot. We wanted to give users an option to overwrite the data when more information was available for them, for example, because we didn't have that much faith in the initial available data.

There are a set of rules that PLP needs to take into account, those are not visible in ROCK. Things that PLP takes into account when suggesting an OTT are not visible when creating a manual OTT. Users can create a manual OTT that is not in line with the constraints they have put in the system for PLP. Making these rules visible would help users to understand better the suggestions the PLP system is making.

I think that the problem is that it is a very complex problem that is a big challenge. PLP will not solve everything, but everything that the optimiser cares about and takes into account should be very well visible on the interface. Users should see how the input they give is affecting the output.

To be sure, the input users need to give to the system is only in ROCK, it is not also on other websites/platforms/systems.

The data that is coming into ROCK is coming from other sources, but operators only need to change this in ROCK, that is correct.

Is it possible to exactly see how the PLP system is coming to a suggestion? Or is that too much in-depth on the mathematical side?
It is a flow optimization problem. The system is correctly coming to a suggestion, everything is in the mathematical model. It is a linear program. It is a multi-commodity flow problem with extra constraints added to the problem. The different types are the different commodities and they would use the same capacity.
If you would put it very straightforwardly, the system uses the input it is getting from ROCK, it uses the formulas shared in the mathematical model, and then it makes a suggestion.
Yes, that is correct.

How are the inland corridors connected in the PLP system? One of the constraints for the system is the vessel schedule, but transport modalities used for the inlands are not on a fixed schedule. How come the system is making suggestions?
This is also a constraint that users can set in the system. They can add and change the prices of inland modalities and change the frequency of departure of a transport modality on that corridor. Then PLP makes an inland suggestion. PLP doesn't make a suggestion on site level, we rely on the users to adjust the site.
And what do you mean by adjusting the site?
The PLP system suggests the correct numbers that need to be transported, however, this is not set to the correct site. This needs to be changed by the operator, with the volumes that the PLP system is suggesting. We plan on pool level but operators need to assign a site themselves. It can be that PLP will assign a site based on historical data, but that might not be the correct one, this then needs to be changed by the operator. The operators need to take action themselves.
Do you know of operators know that they need to take action themselves?
I don't know, I haven't talked to them about this.

D.10. Follow up interview 1

Even though you're using the system, why would you say that you still plan most of you're OTTs manually?
Because the PLP plans that the system is generating now is obviously not realistic. But saying that, I am not diligent in updating all the parameters as I should. Only when I'm really frustrated, but it's also the way you update the parameters. I don't think it's very user-friendly.
You mean with how it is implemented in ROCK?
Yes, in ROCK. The way you go into ROCK and update the parameters for your PLP plan. You can't update for a specific destination. I can only select the servers and the size type. Sometimes I split because I can only send so much to this destination and so much on the same survice. But the destination is a determining factor. In the current system you can't do that kind of update. I think that it should be easier for us to put the parameters in.

Is this is also why you think that the system is not giving the right quality? And why you don't enjoy using the system. Yes
So that you're not using the system is mainly influenced by the quality of the system right?
Yes

And do you feel that if the user friendliness in the system is changed that it would already help you, or is it mainly the output quality?
It think it will make a difference.
And do you feel there should be a training for that, or do you want to give any input in that?
No, I think if they do change it, they need to ask input from the people that are using it so that we can give a real life example of what we need and what we're struggling with so that the system is actually created for us that's using it.

Howcome, you answered the question regarding the resources you can consult with a one?

Whenever I have a problem and I log a ticket for ROCK, I never get the satisfactory answer. That wasn't just for PLP, it was also for ROCK in general. I think there are a lot of experts, but I don't feel they're assisting us. The system is as good as the input data. In Africa we have a lot of issues with terminals and vendors supplying tracking information. And sometimes this information is late and it impacts the quality of the planning.

Is there anything else you want to share about the system that wasn't asked in the survey?
No. I really think if we can get it right, it will add a lot of value for us all. It will make us more efficient, will save time. I think there is a lot of value in it.

D.11. Follow up interview 2

Why do you still plan most of your OTTs manually?
Because PLP does not plan the way I want it, it is either too low, the wrong size or the wrong direction.

Are you restricting the system so it doesn't plan at all?
I did for several corridors but they showed up again, so I stopped. But even if I use PLP, I have to adjust it manually.

Do you think the quality of the system is not right or is it not well developed?
There is a logic in PLP that is not my logic, so I don't if it's well developed because the output it is generating it not making sense.

Can you explain how you answered the statement regarding that the system can improve the quality of your equipment planning?
When it is running perfectly and things like I do, it can improve my quality. But for all system's, not only for PLP.

And for PLP, do you think there still needs to change a lot in order to achieve this, or are it just minor things?
Yes, I think it's just minor things.
Is that also what you answered that the quality of the system is not high?
Yes, and another reason is that it changes the sizes after loading. So sometimes you're looking for positionings and cannot find them anymore, and then you see it's a totally different amount. And if it's in load status, you cannot change it anymore. So you have to calculate.
Is that also why you answered the question that you understand the output of the system with just a 2?
Yes.

If I understand you correctly, all the answers are related to the output and the weird plans it is sometimes suggesting.
Yes.
Do you think that if the output quality is increased that all questions would increase?
Yes.
It's all related to the output quality, the user friendliness or the possibilities the system has?
Yes, sure
Would you say that the overall perspective you have on the system is negative at the moment?
For PLP it is. It is positive and negative at the same time. The idea is super and it's good to have some corridors in the system already. But if it does the planning completely differently, it's negative. So it's both and I don't like it.

Do you feel you can reach out to someone of the PLP development team or help desk if you have difficulties?
I talked to xxx a couple of months ago regarding some strange things, and he explained why things are happening, but he didn't know how to change it. And all my colleges just tell me to delete the corridor.

We don't discuss it anymore with the team, we just gave up and live with it. It might change in the future, but right now we more or less ignore it.

D.12. Output Quality 1

I think that sometimes the PLP suggestions are not really correct. Probably the implementation in going to work perfectly in a couple of months. But for now I can see a lot of PLP suggestions which are not correct. They are going deep red in some locations. PLP is planning the evacuations for too many units and then you have to correct them, you have to check them on a daily basis.

And do you know how the system is coming to those suggestions? Are you using the restrictions or adjusting the input the system is using?
Yes, I'm familiar with the restrictions and I'm using them from my side. But for example you cannot set up the restrictions if you have them from China. You have to contact someone in China to do it from his side.
Because you can only set the restrictions in the area that you're working in or responsible for?
Yeah, for now it is like this, maybe in the future it will change, but for now it's like this. It should not be difficult to check and contact someone from China from the equipment team and ask him to do it. But it still is an extra step.

And for other corridors, are you using the restrictions?
For now we are using only vessel PLP suggestions for inland. We are not using them because you never know when the train is, how much space there is on the train. So we are not using the PLP for the inland positionings.

And for the vessel side, do you think the input is often correct?
Let's say it's more incorrect than correct. But sometimes it's also correct or at least close to correct.

And are you okay with the output the system is giving, or do you feel the output is so off you don't want to use it at all?
I'm using it, but i'm checkin it every day. On daily basis I am checking the port view and then I see if it's in red. I'm going to check and usually it's a suggestion coming from PLP. And we are also putting in some manual but then PLP is adding. And then you have to consult because you are in deep red.

Do you understand why the system is making this suggestion or is it just a big fuss?
No, I don't understand. I thought that PLP is going to respect the availability, but it is not respecting the availability. Maybe some vessel constraints or maybe it is something that needs to be changed.

Are you able to do that yourself or do you think that someone else needs to do this?
I'm able to do it myself for my locations. But it's not that user friendly. Sometimes I need help, I need to ask someone.

And how would you like to output of the system to be?
It is the intention of PLP to reduce the manual work and maybe optimise the supply and evacuations where that it needed. But for now, it is only adding work because you're have to insert your own manual OTT and you're checking the PLP.

So to conclude, the main problem for you for the output qualith is that it is very strange that it is sometime evacuting a lot more than would be logical?
Yeah. I don't know how it works. It seems like it is not taking everything into account. Maybe we should have a focal point for these constraints per country, so we will have less work in the future if someone who is more expert with that arrange everything as per our needs.

D.13. Output Quality 2

Where do you think the current output of the system is lacking to completely adopt the system?
It seems there is no logic behind the directions of repositionings. Second, sometimes there are order for complete nonsense depots. And the next one is the volume itself. It seems that only the vessel volume is counted in and not in relation to the real volume at the destination.

Do you understand how the system is coming to those suggestions?
To be honest, no.
Are you working with the restrictions you can set to the system or the constraints? Are you updating them?
In the masterdata? I usually only use the PLP corridors. But to be honest, I haven't checked them a lot.
Do you know how to update the constraints to have the system work better?
No
And would you like to understand how the system is coming to a suggestion so that you would be able to understand why it is making those suggestions?
Yes. I would love to know that because if I know the logic behind, it's easier to fill up the restrictions. Only if I understand how to do, then I can improve. Because it's my benefit if a PLP suggestion is more realistic.

D.14. Crew management optimizer

What I am mostly interested in is the implementation of the optimiser. What do you think was the main reason that the implementation went well and people are using it?
They started with a small, very tailored product. The scope is also much smaller. Much easier to understand and contain and all in one place. It is also very easy to see the difference between the manually created plan and the optimised one. Very straightforward, very simple in that sense.

And if I think of Maersk, the areas that need to access and receive the empty containers are completely disconnected from each other. In the manual creation of a plan, the human brain, cannot comprehend how the whole thing works, it is so much harder to compare it. The decisions are all made locally in one decision, they seem reasonable and understandable. 'That's how we have done it before', and suddenly, this optimizer tells you you don't have to do that any more. This is really hard to compare with the airline optimizer, the decisions made for empty container repositionings are not so obvious as for airline crew. That is harder to understand for its users.

Reporting is very well developed in my current system. Providing planners with different numbers so that they can analyse and decide. You can test different parameters and see how that would affect the outcome.

It has been five years since I've left Maersk so I don't know where they are with the development. Because users, they are basically given a decision solution made by someone (optimizer) or won' take part. And they need to execute well. It also feels a bit offensive if I imagine for someone, they are like, well, you don't need me at all? It is a very complex problem, it's a culture distribution and personal feelings and the legacy and history and system itself, it's son many things in this.

Did you also experience that at first when you pitched the idea or started with the development? Did you already experienced that bit of hesitation?
There wasn't a big participation. I remember I had a call with guys from the Middle East and Asia, teaching the first ideas because it was a massive change in the planning. We had a meeting of one hour where I almost not had a single word and they just poured all the possible shit, curse words etc. There wasn't just resistance, it was a war.

Eventually I think one of the very good decisions we made was that we actually took these people into our project. Instead of arguing with them and trying to convince them, they were super helpful. Now they understood more of the ideas.

But by the time I was at Maersk there were about 1200 people doing the planning on local level, and all those people you need to come in and get involved and change their mind. It is very important to get those people on board to convince and explain how it works to get them to execute their part of it and not that they're being replaced by a computer.

And do you also think the crew optimizer is working because they are part of the solution and not forced to use the solution?
It's much smaller, usually it's one office where you maybe have a few dozens of planners, it is a different scale. They see the picture every time almost end to end, exaggerating. And the solution was actually beating them, the optimizer.

After working with Maersk I switched here and I was surprised how fast people can understand. Easier grasping it and so much faster. But I think this is also because you're so much closer to the solution, to all the parameters that you can play with. But again, it is hard to compare.

When you started developing the system, did you already thought about the difference there is in the planning for flow planning and the site level planning?
I think it is incorrect to only talk about optimization and PLP because there are three things in all this that are creating the front line and that we're changing. So first thing is of course this optimizer. But another, I would say important, is forecasting. There are certain certainties and that is one of the key elements that drive optimization. So even if you have a perfect PLP plans with all the reports, but the forecast is off, then it will not work and people will see it's making the wrong decision. And forecast are never 100% correct. And then there is another thing the stock target. But it's all these three elements that were part of my first solution that we need to change and make them all in one digital platform and all standardize in a similar way that would enable this to work. And it wouldn't be possible to change only one, that was a mistake IBM made before when they tried to implement the optimization.

But these are all things that are super sensitive to the planner. There are these 200 countries around the world and they all invent their own ways of how they plan and how to pour it out. And then there is this system that is telling them to do it differently. Even thought it's logical and it will al work, but they might no buying into it.

And if you know if the target is off then PLP cannot create a plan, it's all connected. Pilots and crew are so much easier.

Do you think it would be possible to have it implemented in stages?
Of course, but that is what we're doing. So we first implemented the flow on the global level on the global level and then going to more areas and then it should connect.

But again, I think the biggest problem is getting the people on board, getting them to understand how targets are calculated. Mathematically we did some nice things, but again, the people that are actually managing the flow sitting in countries, they are very far from it. Work with them just to put hours and get workshops. See how they see it, and they are often right. But also need to balance where it makes sense to adjust.

Do you think that it would be possible to develop a system that can be used globally, or do you think that it's better to have a system for each region. Because those regions need to interact with each other, but their workflows are so different.
That is exactly one of the challenges, because one is interacting with the other, they cannot be separated. There can be differences in the workflows and how they solve some small things here and there, but it's same platform that is the only way it can work otherwise, you know we will not see where you have supplied and the deficit.

Again, I think it's about 50/50, part the tool development, all the refinement, analysis. And another part is as important is getting people on board.