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**OPTIMIZING THE PHYSICAL ORDER  
TO CASH PROCESS  
IN AN INTERNATIONAL SME**

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<p data-bbox="145 833 1437 896"><b>Abstract</b></p> <p data-bbox="145 896 1437 1052">The research aimed to find an optimal physical order to cash process for the commissioner. The commissioner is small to a medium international enterprise that operates in a niche industry. They import from the USA and China and sell to consumers in events and internationally online.</p> <p data-bbox="145 1052 1437 1209">The emphasis was on the optimization, including timing and physical ergonomics. The Living Lab was chosen as a methodology with open innovation theory due to the versatile and structured approach.</p> <p data-bbox="145 1209 1437 1366">The constructed Living Lab included the current layout of the commissioner and two designed variables: Plan A and Plan B. Plan A was the lower-cost option with optimal shelving, workspace, and designed workflow. Plan B was a custom build unit with internal shelving and trackable workspace.</p> <p data-bbox="145 1366 1437 1523">The Living Lab included timed tests aimed to conclude the variable that would be the most optimal time-wise. Timed tests were finished with all employees on various days and options with different conjoined and singular order processes.</p> <p data-bbox="145 1523 1437 1765">The results found the most optimal physical order to cash process for the commissioner with Living Lab variable Plan A due to its physical, ergonomic factors, efficient time in order completion and workflow design for numerous workers for simultaneous work. Furthermore, low buy in cost also played a factor as commissioner operates in a niche field, where the future is unpredictable.</p>		
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## 1 INTRODUCTION

This research was done about optimizing the physical order to cash process in an international small to medium enterprise, which is based in Finland. The commissioner operates in import and in sales within the business to consumer industry. The commissioner imports their goods from China and the USA to Finland, which they sell in events and online. The commissioner sells directly to consumers worldwide. The commissioner operates in a niche industry with a steady flow of customers that are active in that industry.

Research for the thesis was done using the Living Lab methodology. Living Lab was chosen as a methodology due to its versatility and applicability within physical processes. The Living Lab utilized the current warehouse layout as a basis. Two different variables for the physical layout of the warehouse were designed using open innovation theory. Open innovation theory was chosen due to its possibilities. The two different variables were designed as a low cost and higher cost possibility for optimizing the physical warehouse and the physical processes within.

The qualitative research method was chosen for the thesis as it is applicable for research that included testing with different variables. The limitations of the study include the two selected variables within the built Living Lab and the timed tests. Timed tests were performed with different workers and different days as the actual timing might affect the times as well as the human implementation.

Based on the Living Lab created, the optimal order to cash process was recommended to the commissioner based on the foreseeable future of the company. A big monetary investment was not recommended. Based on the evaluation, the commissioner can optimize the physical OTC (order to cash) process by using the space and tools on hand and therefore better their business management overall. Optimization of the physical order to cash process also reduces the need of overtime work and peak season extra labor force.

## **1.1 Thesis background**

The thesis background is an international SME (small to medium enterprise) that has a single platform for physical order to cash process fulfilment. The thesis is about designing an efficient structure for physical order processing, optimizing the current structure. To find out the most optimal physical order to cash process for the commissioner, Living Lab methodology was used.

Testing in the Living Lab was made with the current layout and with the two designed variables of prefaces with the commissioner's workers. The main points in the designs were to consider efficiency, stock placement, workers physical ergonomics and order fulfilment times. The invented variables for the platform were designed as the low cost and higher cost option at the point of purchase by the thesis writer as part of the thesis.

The commissioner operates from a single physical warehouse and sells goods through various events and online. The issue of optimizing the physical order to cash process arose from the idea of whether new employees should be hired. In order to keep fast delivery times or could the order to cash process be more efficient to minimize and optimize labor costs. For international orders, the internal processes are important since delivery to foreign countries takes longer than national deliveries. Particularly as order flows are inconsistent and peaks occur due to changing seasons and events.

## **1.2 Aim and objective and research questions**

The aim of the thesis is optimizing the physical order to cash process regarding work processes and the time of their conclusion as well as considering the time and the labor costs. The objective of the thesis is optimizing the physical order to cash process of an international SME. The recommendations will be concluded by using the results of the Living Lab and configuring what is the best way towards optimization in regards of order processing time, efficiency in execution and physical labor attributions.

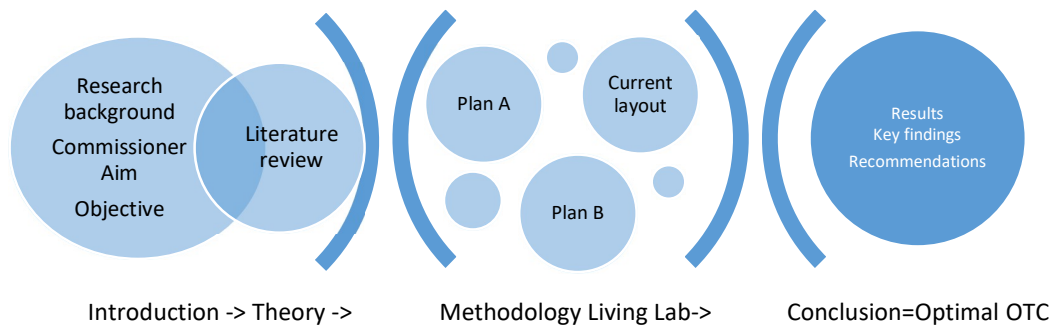


Figure 1. Structure of thesis (Salo 2020)

### **Main research question:**

What is the best way in optimizing the commissioner's physical order to cash process?

### **Sub research questions:**

What is the best optimization considering time and cost?

What is the best optimization considering the workers labor conditions?

The research problem is configuring the optimal physical order to cash process for the commissioner, so the commissioner can manage their business more efficiently. In research and theses, the optimizations of the order to cash processes are focusing mainly on the IT systems and speeding of the money circulation. This thesis concentrates on actual physical order processing. The focus was set upon the physical processes and efficiency as well as workers physical ergonomics, as improving physical processes will also speed up the money circulation.

### 1.3 Thesis framework and limitations

The thesis theoretical framework includes the theory used behind the Living Lab. Combining open innovation theory with the Living Lab methodology gives a broader spectrum of designing the Living Lab, which makes the thesis research questions even more critical. When designing the Living Lab, the preface of a low cost and a higher cost option was a determining factor of the different designs.

The theoretical framework also included physical ergonomics in logistics as it is a relevant topic when designing an optimal physical order to cash process.

Workers physical ergonomics is what increases labor costs in the long run with possible sick leaves or other physical issues and possibly lower work pace. One-sided work is a key aspect in warehouse ergonomics that needs to be addressed when optimizing physical processes. (Tamminen-Peter et al. 2015, 9).

The thesis framework was made to keep the research valid and limited to relevant data. Limitations of the study include having only two different variants to the current layout of the physical order to cash process. Yet those limited number of variants were needed to keep the research focused and within its framework. It is important to comprehend that optimizing the physical order to cash process is an important part of business management.

When the research data of the thesis is based on manual work, some of the limitations concern workers. Some workers work slower and others faster. Yet those are the employees that would work with the planned variables; therefore, the possible variations of workers working times are not relevant for the study, as the same discrepancies will appear in real life, which did in the Living Lab testing. Different workers conduct their work at different times as well as the actual timing is likely to affect the workers performance. (Wetcher-Hendricks 2011, 4-5).

A framework limitation was also the fact that Living Lab testing times were not designed thoroughly prior to Living Lab planning. Fortunately, when planning the Living Lab, a segmentation of timings was thought out, which rose to be a key factor of the testing and the later recommendations. Processing conjoined or

separated orders in each of the three variables tested in the Living Lab were different, with some variables more prevalent than others.

#### **1.4 Research methods**

In research, it is important to describe the needs as detailed as possible for the developmental value of the end product to result in action. Action is likely to be more scattered if the needs have not been described properly in the original research. Thus, research design and focus can be multifaced, yet it needs to be presented detailed and accurately. (Solmaz 2021, 108-110).

The research method in this thesis is a qualitative research method. The method was chosen due to its applicability in optimizing international small to medium enterprises physical processes. Living Lab methodology was used as with the method; there are endless possibilities in creating variables that can be tested in a monitored environment. Due to efficiency and staying with the thesis framework, two new variables were chosen to be tested.

Variables included a custom-made built order processing installation and a variable with the current facility yet efficiently organized and placing products, tools and workers with the most optimal way of processing time and ergonomics of the workers. With the chosen research methods, the most optimized process was thought to be found. With optimization the key is not to be error-free, but to be able to manage the possible errors accurately. (Pagano & Gyimah 2016, 37). Longevity is important when managing, for example, the workers' physical ergonomics as ergonomic issues may arise only after years.

The aspects chosen for evaluating the different variables that were tested in the Living Lab environment included the perceived benefits in labour costs, time consumption and efficiency. The benefits were questioned regarding the current state of the company and its future prospects by the researcher. Numeric data was used in the evaluation.



## **1.5 Commissioners current situation and desired outcome**

The physical warehouse of the commissioner is a single platform with standard warehousing and packaging solutions with shelving and desks located in Finland, wherefrom the commissioner is operating internationally. Considering, both efficiency and workers ergonomics, Plan A and Plan B solutions were designed as possible replacements of the current physical process. Due to the fact of the two variables being so diverse, a difference of separate and conjoined orders was also measured and tested in the Living Lab.

The added variable of testing separated and conjoined orders was not in the original plan, yet it was discovered in the planning phase of the Living Lab and added to it due to its potential value to the research. Testing with only the two new variables compared to the existing process would not have displayed the physical order to cash process accurately as the company's workflow does vary. Thorough planning of the Living Lab process allowed this issue to be discovered even when it wasn't discovered when planning the actual research.

The current state of the physical warehouse concerning workers physical ergonomics was not ideal. There was heavy lifting from uneven surfaces and uneven work surfaces. The workflow was not designed considering physical ergonomics and included mostly one-sided processes that could be designed differently. Insignificant work was included in the work processes that could be deleted with a more efficient product and tool placements.

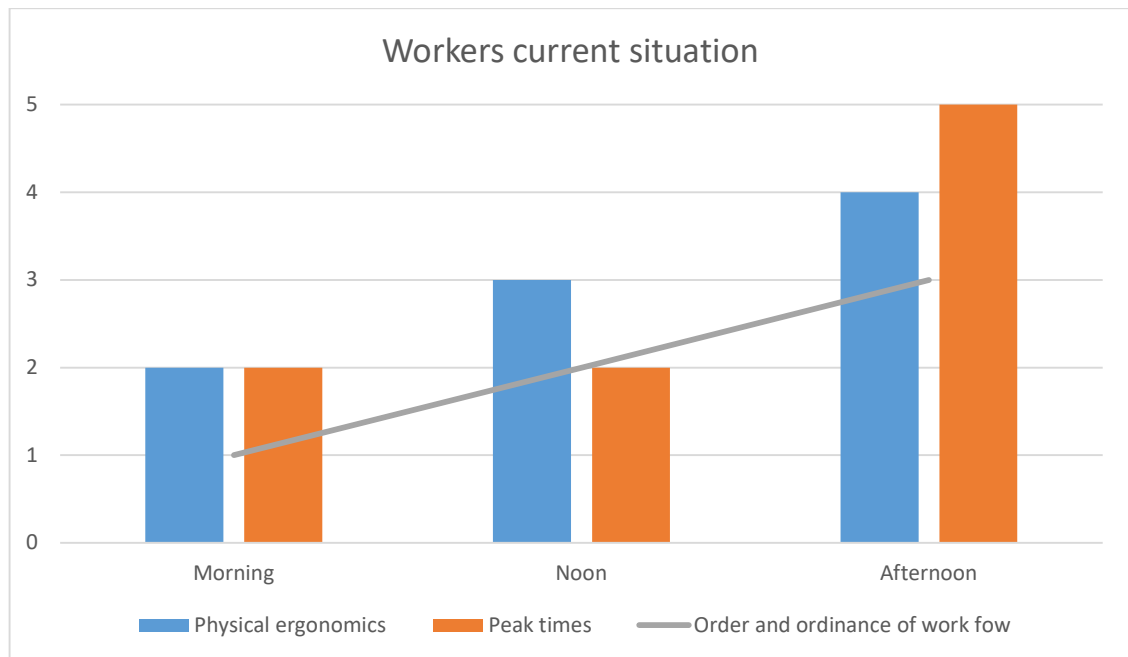


Figure 2. Workers current situation (Salo 2021)

Workers were asked during the Living Lab planning phase how they saw their workflow currently. The answers were rated from 1 to 5, with five being the most uncomfortable for the worker. The situations were rated from the morning – noon to – afternoon. During the Living Lab one of the segmentations of the Living Lab testing times was designed to be separated and conjoined orders.

The reliability of the logistics chain is as good as the chain's weakest link. In this modern age consumers tend to order from the online stores from which they will receive their goods the fastest. If your customers are used to receiving goods fast and suddenly, they do not receive them as quickly; one might end up losing some of the customers. Especially for international customers, which deliveries take longer than national customers, the optimal physical order to cash process is important.

When thinking about the desired outcome, the processes needed to be laid out. Analysing the processes to identify the key issues is crucial in research. (Robertson et al. 2015, 8). Evaluation during the process is also crucial to stay on the right path. It is crucial in the deciding stages of designing the Living Lab

methodology to keep in mind the objective. Without doing so, the answers to the right questions might not have been received at all.

The companies work efficiency and productivity also depends on the supporting functions (Hedin et al. 2014, 186). For a company like the commissioner, the physical order to cash process is a supporting function, as it is merely the way to get the purchased goods to the customer. Yet it is the most crucial part of the customer's experience after they have made the decision to purchase and affects highly in the return rate of the customers.

A company's desire is ought to be an intelligent organization. Establishing a high impact intelligence organization includes an executive-level champion; the deliverables; demonstrating; learning about the market for intelligence services and building external partnerships; networking with companies from different backgrounds (Hedin et al. 2014, 128). The deliverables can be improved with an adequate Living Lab, which can answer to all the questions asked in the beginning of the research.

In the planning phases of the Living Lab, the high-cost option, the custom-made built invented and designed for the commissioner was researched regarding all the needed supplies and their order in appearance for the order to cash process to be corrected in the built. The small storage spaces for products in the built were measured so that all products would fit in there and future possibilities with overseeing the overall markets. Detailed decisions affect the outcome of the result, usability and overall business management.

The commissioner's desired outcome was to be efficient in its physical order processing while lowering the curve of peak hours and seasons with the workers' physical processes. This outcome could positively affect the company's other processes, such as customer service response times and marketing possibilities, without adding a workforce. The management of the commissioner could affect the workers' processes positively overall in the commissioner. The planning of the

desired outcomes for the commissioner is open as the physical order to cash processes significantly affects other processes within the company.

## **2 PHYSICAL ORDER TO CASH PROCESS, OPTIMIZATION AND ERGONOMICS IN THE LOGISTICS INDUSTRY**

According to Rushton and Oxley in (1991), there are three different sections in customer service: before the transaction, during the transaction, and the section after the transaction (Hokkanen et al. 2004, 349). The last section for the commissioner can be considered as the delivery of the product to the customer. If the time exceeds the customer expectations, the overall feeling of the company might change into a negative one. Even if all other sections were positive in the customer's eye, the last phase is a memorable one. The market intelligence cycle explains how utilization and feedback are important to understand customer behavior. (Hedin et al. 2014, 78-79).

Part of designing efficient and optimal physical warehouse activities is to consider all of the parameters, the ones concerning order fulfilling directly or indirectly. The dynamic parameters that are in use in the everyday warehouse guidance are supplement- and order frequency, order quantity and transport capacity (Hokkanen et al. 2004, 151). Transport capacity is something that small to medium enterprises tend to have outsourced, and therefore controlling those costs might be challenging without the inclusion of the order quantity and frequency, and this is even more magnified when talking about an international business.

Physical order to cash processes differs greatly depending on whether the company or entity in question is a small independent single platform operator or a multinational company with centrally located warehouses. Efficiency is crucial in all of them. Efficient management of a warehouse starts with having the correct processes and facilities, and when having those, it is crucial to have correct staff in operating them, in management and warehouse personnel. (Robertson et al. 2015, 6).

Major bottlenecks in the purchasing process model include supplier and brand specifications are; inadequate supplier selection; insufficient contracting expertise; too much emphasis on price; and administrative organization (Weele 2002, 35-36). These bottlenecks can be managed differently depending on whether the company in question is a small or a large organization. Sufficiency is the key in all aspects of business management. It is up to the organization to map out what is sufficient for their organization to work optimally.

Success factors in purchasing departments include easy access, fast reaction to questions and problems; prompt delivery; consistent quality of delivered goods; immediate feedback of order changes (Weele 2002, 328). The commissioner has recognized their bottlenecks coming into effect during peak times due to inefficient physical order to cash process. This lack of efficiency directly affects their prompt delivery possibilities.

The aspiration for the right costs is the aspect that gives the most significant challenge to logistics planning. (Hokkanen et al. 2004, 21). Labor costs are one highest cost concerning logistics overall. It is important to plan the logistics chain as precisely as possible so surprises will not appear or they are cut to a minimum. Inventory control is the function that levels the costs, delivery capacity and quality in a way that gives the best added value to the customer and the company (Hokkanen et al. 2004, 216). Inventory control is something that SMEs might struggle with. They might not have enough free capital to have extensive inventories, so they have to compensate in other terms that need to be tough out carefully in international business.

Evaluating any type of measurement is essential. Statistics were used in this research. Statistics means the numerical data and the procedures and techniques for collecting, describing and interpreting the data. (Campbell 2021, 15). When deciding from various options, it is critical that the statistics show what was asked to be shown and were planned properly.

Different logistical forecast based structures include MSS: making and sending to stock. MTS: making to stock. ATO: assembly to order. MTO: making to order. ETO: engineering and making to order. (Weele 2002, 212-213). The commissioner's structure is MSS as they purchase ready-made products. With limited storage capacity due to inventory and its monetary values, is it crucial to manage the warehouse proficiently? A significant variable for the commissioner is also the ability and willingness to work on separate or conjoined orders. With those depending on the layout of the warehouse, the possible set-up times might alter order fulfilment times drastically.

The market intelligence cycle includes six phases: needs analysis, covering secondary information sources; primary research; analysis; delivery; and utilization and feedback (Hedin et al. 2014, 78-79). Optimization is being more market intelligent, and the cycle is also in the forefront of the thesis and its objective.

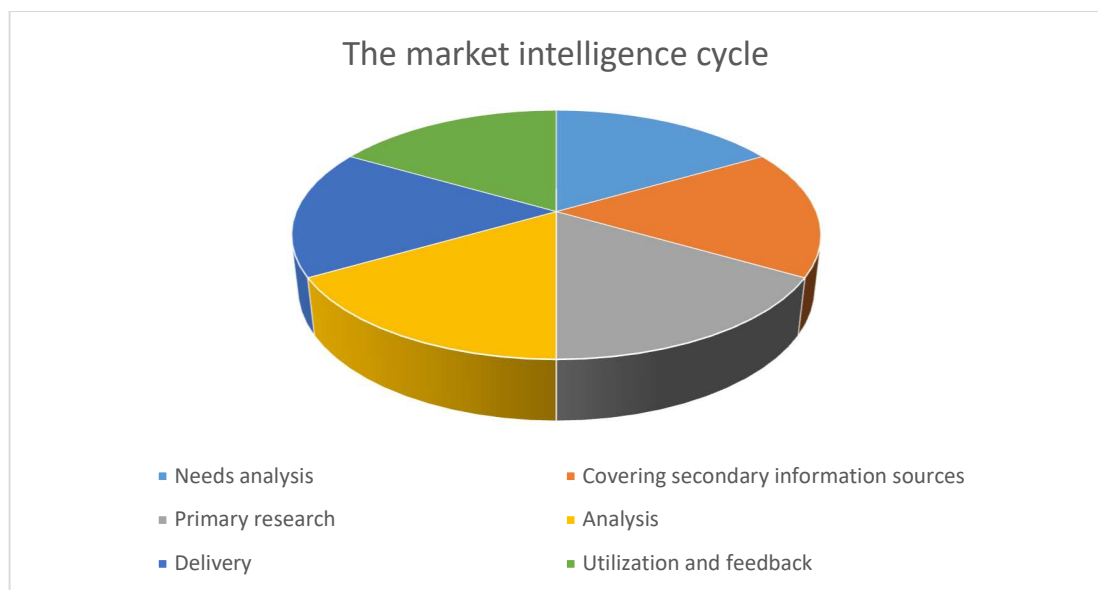


Figure 3. The market intelligence cycle (Hedin et al. 2014, 78-79).

As part of creating the Living Lab for the thesis there was a primary research phase and a needs analysis which was conducted. Core of optimization is being more intelligent within the market and winning customers over, from an outside perspective. Analyzing is an important factor in any optimization process as the

results might reveal something unexpected that might change the further process of the optimization. The aim of optimization could be exceeded yet it is important to make the primary research thoroughly for the analysis to reveal the needed data.

## **2.1 Commissioner's current physical order to cash process**

Current facility for the commissioner's physical order to cash process is a standard warehouse typed room which has shelving, desks, and space for incoming and outbound parcels. With the current layout, workers would package some items directly from the inbound boxes if the specific products would still be these and laying out of the boxes was a part of the order to cash process due to insufficient shelving and product placement.

The placement of the items needed in the order to cash process, was lacking thought. It is important to view the process as a whole and consider the step before and the step after you are doing currently when designing the space. Also including the set up and closing process and time is important as they are included in everyday work.

Even if a worker in the commissioner is not solely doing physical order to cash process and is working on the processes within the company, the order to cash process still need to be valued and seen as a full process. Working uninterruptedly is important and affects the time when the particular process is concluded. Having a workflow that works smoothly requires all the steps of the process to be laid out and designed.

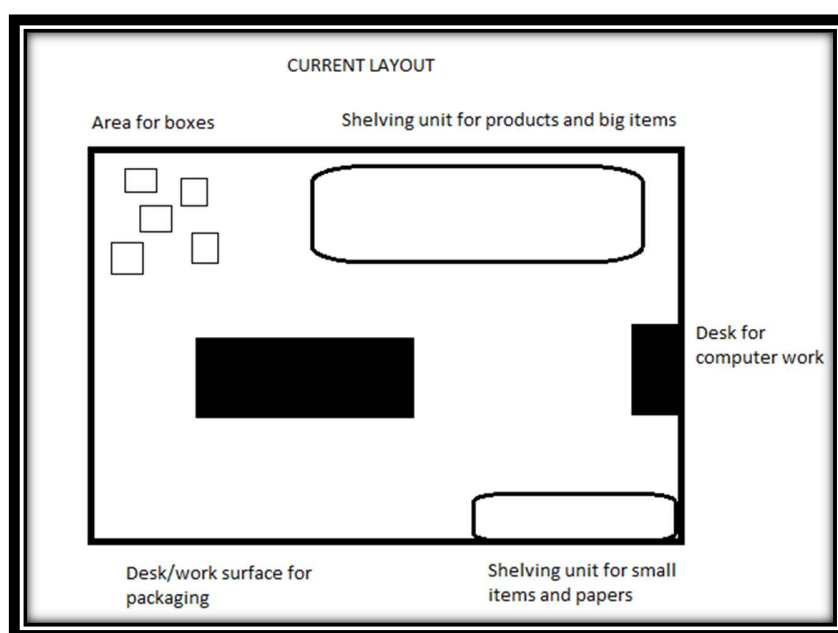


Figure 4. Current layout in commissioner (Salo 2021)

The commissioner's facility was firstly a place of storage and secondly a physical order to cash processing facility. In physical ergonomics it is important to consider product placement in height, width, and length wise to assure the most optimal angle for the worker. (Mocan & Draghici 2019, 2-5). When there is a work space that multiple workers use, it is important to assign a specific area to conduct a certain part of the process, since it will make the process more clear and will minimize the discrepancies that might occur if different workers work differently.





Figure 5. Current physical order to cash process (Salo 2021)

Currently there are numerous gathering phases in the commissioner's physical order to cash process. The commissioner was ad-here to the legislative regulation, yet they lacked on the operative insight in the management level which needed to address the issues of the physical order to cash process. (International ergonomics association & international labour organization 2020, 9).

The commissioner's current layouts set up and closing times were time consuming. In the layout there wasn't a possibility to permanently place items and tools needed in the physical order to cash process in the warehouse which were needed to set up and close each time. Small aspects in the physical order to cash process were repetitive and time consuming and as there were many of the small aspects, they pile on and create a valuable amount of time which could be utilized in a more productive way.

## **2.2 Physical ergonomics in logistics industry**

Physical ergonomics in logistics industry differs with workers who work in an office, drivers and workers operating in warehouses and terminals. Workers who work in warehouses and terminals operate in the context of manual labor and some also are operating different kind of vehicles. This research focused on warehouse workers physical ergonomics. Different workers have different issues in physical ergonomics yet they all should be addressed in their companies by the management, as workers who are physically well, are more productive. In a business management sense, all employees; low level as well as top tier need to have adequate work spaces and tools.

The thesis conclusions include the matter of workers physical ergonomics as this might relate to labor costs for example through sick leaves. Physical ergonomics in physical order processing includes examining work postures and movements. (Musculoskeletal disorders 2021). The process of managing physical risks includes: assessing the risks; planning goals, actions and timelines; executing; follow up and reporting (Tamminen-Peter et al. 2015, 9). In designing the two variables to the physical OTC process in the Living Lab, managing physical risks was included.

One of the key points in designing the variables was to reduce the one-sided physical work within the physical order to cash processes. This was to be implemented in both of the designed variables. In the low cost option, the optimal product placement would be the key. In the custom-build, the whole design with measurements of products and the spaces for them and the tools in the build would serve in the optimal physical process.

It is crucial to withhold from sustaining the same bad position for long periods of times and it is crucial to work in a balanced posture/position (Tamminen-Peter et al. 2015, 16). Working with the same positions in order processing in warehouse activities is evident yet it is important to design the warehouse placements in such an order that the work is conducted towards both sides of the human body.

In order to be able to design a physically efficient OTC process for the commissioner ergonomically; in the initial observing stage the possible one-sided movements were observed as following. When receiving international goods; refers to positioning and turns when receiving big, palletized goods and unpacking and placing them. When receiving an order; refers to the tasks in working on the computer and with the printer. When packaging orders; refers to the placement of the stocked goods. When fulfilling the order; refers to the placement of the working desk and packaging and the collected goods for the specific order. During closing-time; refers to the placement of the appliances and tools that are used for working as well as daily clean up tasks.

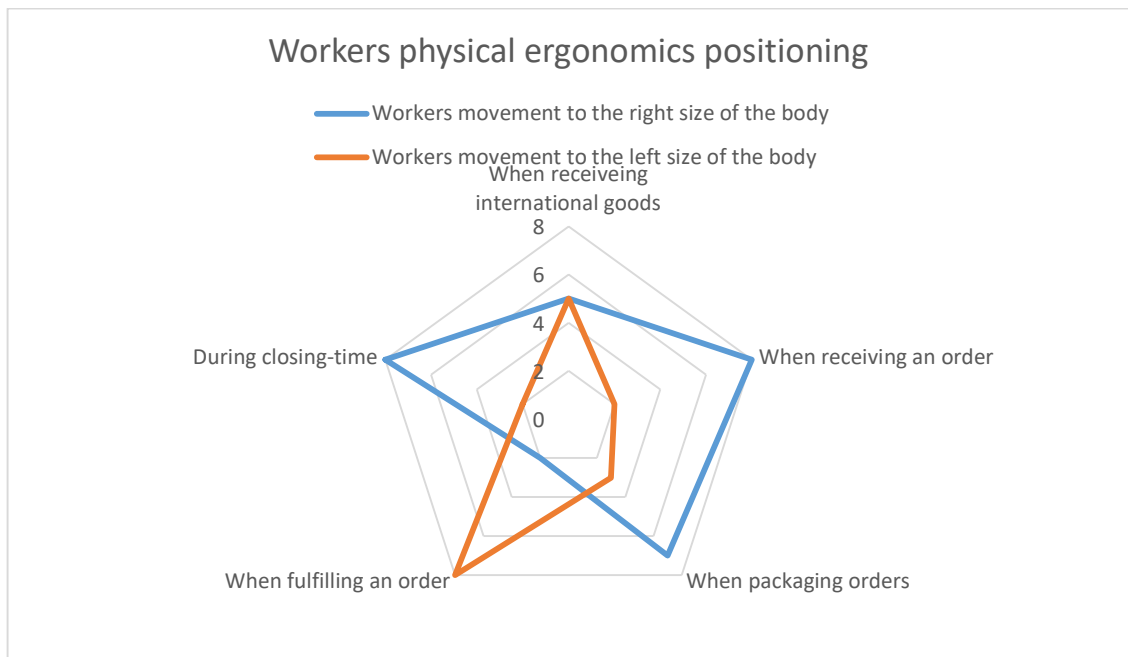


Figure 6. Workers physical ergonomics positioning (Salo 2021)

Applying the VIEW test in packaging includes visibility; information; emotional impact; and workability (Albaum et al.2005, 407-408). Adapting the VIEW test in the thesis concluded in the ideology of information of the products and supplies. The emotional impact on regarding on how to work within the space that is available. Regarding workability; currently there are too much of repetition of phases and one-sided work as we can see from figure 6.

According to the VIEW test, the decision areas in physical distribution are nature of the shipment; transportation; warehousing; materials handling; carrying inventory; and order processing and documentation (Albaum et al.2005, 580-581). Applying the view test in the planning phases of the research opened the horizon for all the aspects which needed to be considered in the Living Lab and optimization of the commissioner's physical order to cash process.

### **3 RESEARCH PROCESS AND DATA COLLECTION AND ANALYSIS: LIVING LAB**

The coordination of the Living Lab environment, the participants and its overall network is crucial, and it needs to be well structured before the usage can even begin. Living Lab will only give answers to the question you thought out to ask during the planning of the Living Lab. (Leminen 2013, 5-6). Coordination and participation approach are adjacent with top-down and bottom-up constructions with provider-, enabler-, utilizer-, and user-driven mechanics in the census of exhalation- and inhalation-domination divide (Leminen 2013, 11).

The work before the actual Living Lab should be implemented, is in some ways even more important than the actual Living Lab. If the Living Lab is not well enough structured or planned it will not give viable answers and solutions. It will not even answer to the right questions and there for is not an asset to the business nor their management.

Living Lab is a relatively new way within co-creation methods for companies or different entities. They can for example commercialize and upscale an innovation which means testing the innovation in a real life setup facility (Veeckman et all 2013, 6). There are still debates on the definition of Living Labs and the topic lacks re-search (Veeckman et all 2013, 7). Living Lab in SMEs is not known that well currently (Santone et all. 2020, 3).

Living Lab characteristics can be divided into building blocks. The blocks are the technical infrastructure, ecosystem approach, level of openness, community, life span, scale, and real-world context. They are all a part of a single pillar of the

living lab building block. The second pillar includes evaluation; context research; co-creation and user role. The third pillar includes the innovation outcome (Veeckman et al. 2013, 8-9).

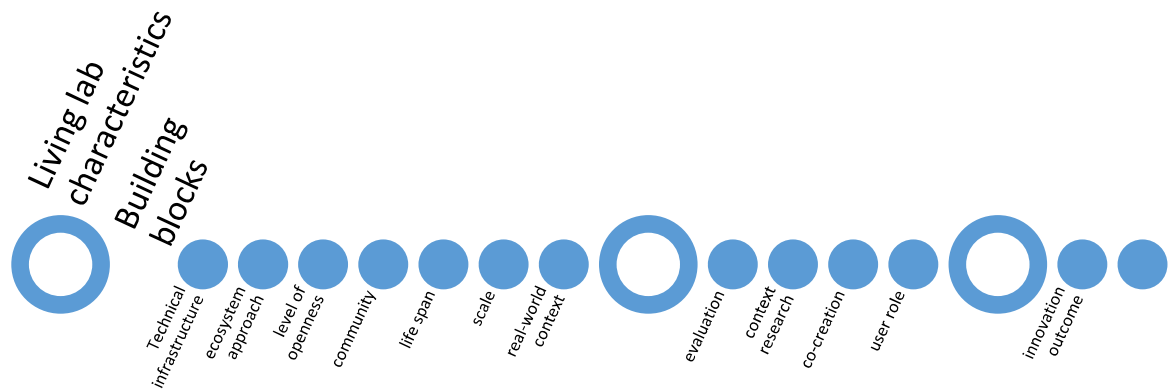


Figure 7. Living lab characteristics (Veeckman et al. 2013, 8-9)

There are different kinds of Living Labs. Living Lab environments can be used to serve research purposes, corporate, organizational, and intermediary or as time limited purposes. (Ståhlbröst & Holst 2013, 6). Living Labs can be a community effort of be aimed to improve a certain function within a company as in this research.

The key principles of using Living Labs should be that they bring value, influence, sustainability, openness, and realism to the task at hand (Ståhlbröst & Holst 2013, 10). The level of openness varies within the context of the Living Lab. Living Lab has the potential to be open for example within the company which it is built for and not externally if desired.

The thesis Living Lab was constructed within the Living Lab building blocks yet in a smaller scale. The Living Lab had no context to ecosystem approach, yet all other building blocks were utilized. Community in a sense of employees, life span

regarding a working day and scale as the work had to be scaled to all employees and user role as referring to the actual workers of the commissioner.

Open innovation theory was used when designing the alternatives for the physical order processes for the commissioner. Companies might turn to open innovation when they are under- or overperforming. When embarking on a journey with open innovation major organizational changes may result. Realizing the company aspirations, the open innovation might not be needed, if the aspirations are not significantly higher business as usual can be in some extent an easier way to proceed with the same style of management and processes. (Alexy, Bascavusoglu-Moreau & Salter 2016, 2-5).

Open innovation can be thought out in three different processes. Theoretical developments in open innovation include schools of thought, actors and processes. The three different processes in open innovation are outside-in process- where the knowledge in the company is enriched through integration. In the inside-out process the company externalizes their innovation and knowledge. In the coupled process there are complementary partners that do co-creation. (Enkel, Gassmann & Chesbrough 2009, 312-313).

For this thesis the outside-in process was utilized within the open innovation. Knowledge sources in outside-in processes in open innovation can be public and commercial research institution. With this Living Lab it was important to keep the objective in mind and not derail from it. Long term innovation success was be affected negatively if a company is too open in the innovations as they might derail from their core. The increase of awareness of the possibilities in mass customization and the importance of innovation networks has also been seen. (Enkel, Gassmann& Chesbrough 2009, 312).

Human capital can make open innovation more engaging with research and development (Alexy, Bascavusoglu-Moreau & Salter 2016, 10-12). Human capital in the commissioner means testing with various workers in order to get the accurate variations of order execution times in the real working life in the

commissioner. The developmental value in designing the Living Lab based on the workers ergonomics increases and makes the research more engaging.

### 3.1 Commissioner Living Lab

The Living Lab model was used as an invention and testing ground for the commissioner future platform possibilities, for their physical order to cash process. This model offered limitless possibilities that needed to be thought out carefully before the actual Living Lab was tested out in order to assure that the right questions will be answered. This Living Lab was not open to the public as some of the Living Labs might be. The Living Lab was only open to the thesis writer and workers of the company as this was more viable solution from a managerial perspective.

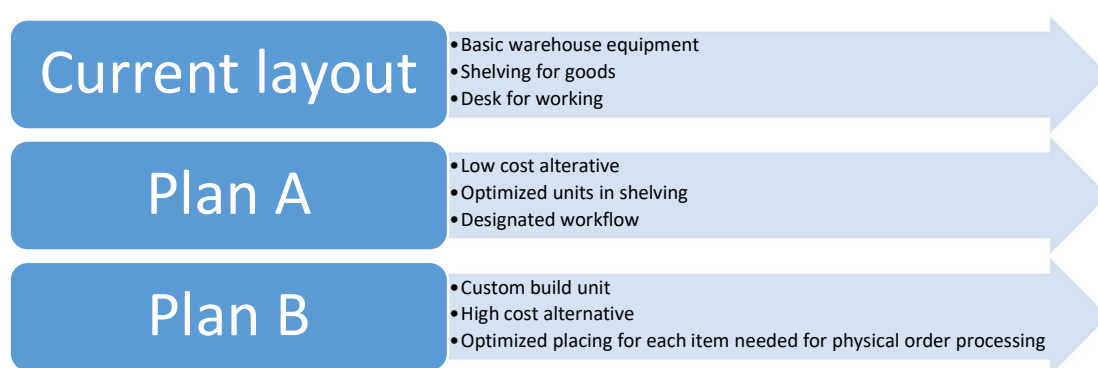


Figure 8. Commissioner Living Lab variables (Salo 2020)

As the commissioner's structure is MSS, the logistical forecast structure when designing the Living Lab was based on the data, the commissioner had accumulated on their daily order rates. (Weele 2002, 212-213). In addition to the commissioner's original plan of simply timing the physical order processing times, based on literature the decision was made, to add the differences of timing various conjoined orders and their fulfillment times. Working in batches is common in many different areas in working and in personal life such as in sending overdue notice and accepting people on amusement park rides. These are due to it simply making more sense in accumulating a specific amount of a process for its fulfillment to make sense. (Bradley 2015, 30-31).

Commissioner had various expectations that were thought out when designing the Living Lab. Expected results for the company were shorter order fulfillment times, increase in work efficiency and possibly the deduction of workers sick leaves. Expected results for the workers were more workable space, more pleasant product placement and less possibilities for work injuries. The expected results for the society/customers were faster order fulfillment times for their ordered products.

Quantitative research method was used to analyze the outcome of the Living Lab. The discovered processes that were used in the thesis are the dynamic parameters. Dynamic parameters are measurable and can be used in business management. They are in use in the everyday warehouse practices which are supplement- and order frequency, order quantity and transport capacity. Those factors play a significant role in the possibilities in planning of the optimal warehouse structure. (Campell 2021, 15).

Physical workload and its theory were needed in the research and when designing the Living Lab in order to understand how the workload affects workers and what are the optimal work positions and their duration. There are requirements from the labor laws which need to be met. Above those, the optimal workload is, what will minimize sick leaves and boost workers morals. Efficiency in the order fulfillment was looked at from the physical workload perspective. (Physical workload 2018). Efficiency is affected by placement of products and the order the workers use each product in the packing phase affected the efficiency.

Order fulfillment times with Living Lab tests were analyzed using quantitative methods. In the final analysis the results and the workloads and company structure were considered when giving final recommendations. It is crucial to look at the whole picture of the company needs in order to conclude what is the optimal order fulfillment process. Contingencies and disruptions are important to consider as they occur in the work life, Living Lab testing with various order



types- with conjoined and separated orders became even more important also in that sense.

Workers attributes in testing of the Living Lab were crucial for the implementation of this thesis. When inspecting the ergonomic factors of the order processing variables were needed. It was crucial for the testers to be different in their workflow and heights and being authentic when doing the testing and evaluation prior to the Living Lab testing.

### **3.2 Data collection and analyzing methods**

The needed data for the preface of the Living Lab was collected from the physical warehouse visually and from examining the current processes with the workers. The current workflow and process orders were examined and analyzed. Testing times in the three different variables varied with workers and within separate days.

Timed tests included the set up time, order fulfillment time and close up times in order to see the differences in the full physical order completion time for the current layout, Plan A and Plan B. The order of workers was not preplanned more than who was present at that specific date, making sure everyone would be timed. The introduction to the Living Lab for the workers was made before the timed tests, so they would be accustomed to the new workspaces. With Plan B as the Living Lab was merely a mock up of the designed custom build, the workers were advised of that as the final product would not look the same.

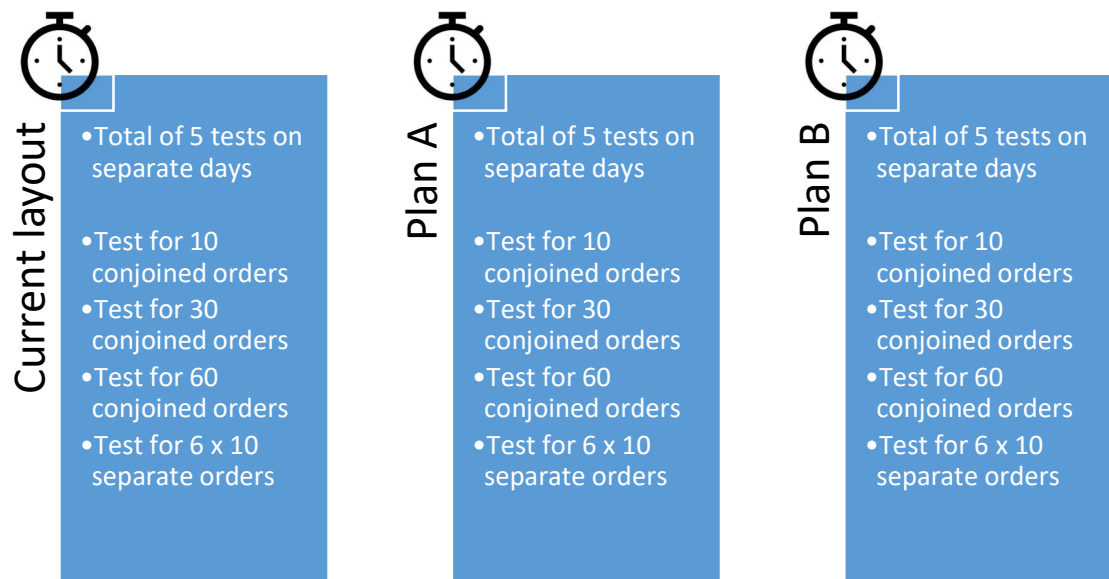


Figure 9. Commissioner Living Lab testing (Salo 2020)

Analyzing methods included analyzing the numerical data while considering the owners views on the current state and prospects of the company. Analyzing methods need to be present already early, when constructing the Living Lab since the Living Lab will only give answers to the questions that were asked in the beginning. (Leminen 2013, 5-6).

The data collection was planned with the commissioner with the management as well as with floor workers. The timed tests were conducted with actual orders therefore the tests were conducted as the orders came into the commissioner. The data was gathered to an excel sheet with the various workers not being named in them. This was done in order to show accurate variables of the workers order fulfilment times that would represent the real-life working conditions. (International ergonomics association & international labour organization 2020, 37).

Analyzing methods of the timed tests of the Living Lab were done using excel worksheets with analyzing the average times of the tests as well as counting percentages of the variables and the prospects of the optimal order to cash process which would be presented to the commissioner and its management.

The number analyzation was conducted purely from a number perspective. In the key findings and proposed implication phase the possible prospects and personal professional opinions were considered. (Campell 2021, 15).

The data collection and analyzing methods in the Living Lab were concluded only in the planning stages of the Living Lab, not during the planning of the original research, as the variable of conjoined and separated orders was thought out only during the planning of the Living Lab. During the data collection time, the workflow at the commissioner was different yet no orders were delayed from being shipped due to the Living Lab and research. Having daily pick up/shipped times in the afternoons, gives flexibility to plan the workday with one target time in mind.

### **3.3 Designing of Commissioner Living Lab**

Open innovation theory was used when designing the Living Lab variables. One of the designs, the lower cost one, is merely a well thought out plan of layout, basic warehouse furniture and product placement. Whereas the higher cost option is a custom-made installation which includes height measurements of staff members and variables for different heights as well product placements for different shapes of products all in an accessible yet variable structure. (Griffin et al.2014, 283).

The designing of the Living Lab for the commissioner included the initial phase of examining the current model of physical order to cash process as well as interviews with the company of their ideas and wishes for their future and dilemmas with the current order to cash process. Examination of the current process was done with mapping out the current process and workers movements, while functioning and measuring the space for the physical process.

Interviews were done with the head of the company while examining the data of orders and current capacity of order fulfillments. Open end questions included future visions of the international company and budget for the project. Floor

workers were also interviewed regarding the current workflow and their ideas of improvements were asked.

During the design of the commissioner Living Lab the market intelligence cycle was in the process with its six phases: needs analysis; covering secondary information sources; primary research; analysis; delivery; and utilization and feedback (Hedin et al. 2014, 78-79). The market intelligence cycle came into place when analyzing the needs of the commissioner. Talking to the management as well to the workers of the commissioner covered the secondary information sources. Primary research was conducted with examining the current layout of the warehouse. Analyzing the data and designing the possible suggestions for a different outcome with the Living Lab methodology. Delivery was conducted with the testing phase of the Living Lab. Utilization and feedback are within the conclusion and suggestion whether the commissioner decides to implement the suggested changes.

After deciding on the two different variables to be tested out in the Living Lab, low-cost and high-cost options, the designing of them began. The methods were chosen based on the current processes in the company and with interviewing the company owner and discussing the needs and the possible future prospects. The two alternative designs, Plan A and Plan B were invented and designed specifically for this research and for the commissioner. (Ong & Joseph 2014, 135).

Studying the LFP, logistics functions of packaging; gives an insight on the storage, flow information, size and handleability of the packaging which is an important factor when planning an optimal physical order to cash process. (Fulconis & Philipp 2017, 25). Logistics is a part of every process conducted in a company, where there are moving parts. Packaging and the needed tools for packaging are in many of the elements in the physical order processes and during the designing of the Living Lab the logistical functions were considered.

The VIEW test was applied in designing the commissioner's Living Lab in areas of warehousing; materials handling; and order processing. The VIEW test encouraged to critically think the importance in the areas of warehousing. (Albaum et al.2005, 580-581). Materials handling prior to the actual physical order processing in the commissioner's was also part of the Living Lab, as received inventory should be stocked in a way which makes the physical order processing as optimal as possible. In this way there are no unnecessary repetitive work processes when the materials handling and order processing are considered as a linear process, one preceding the other.

Segmentation for conjoined and separate orders, of the timed tests was added to the tests when designing the Living Lab. The segmentation was not thought out during the initial phase of planning the research. The segmentation is important as it shows the current workflow and the possibilities for the future with processing orders in preplanned segments. The segments were chosen as 10, 30 and 60 conjoined orders as well as 6x10 separated orders. The segments were chosen after examining the current physical order to cash process and the daily order variables the commissioner had.

When planning the commissioner's Living Lab the possible bottlenecks in the purchasing process model were examined. The area which the commissioner needed optimizing was within the administrative organization as the decisions of the physical processes are decided there. (Weele 2002, 35-36). Success factors in purchasing departments may lay heavily on the physical order to cash process and the research can help the commissioner improve their success rate in prompt delivery. (Weele 2002, 328).

### 3.4 Living Lab variables: Plan A and Plan B

Designing the Living Lab included considering the total process of the physical order to cash process. This included set up and closing times, the changeover time, between phases of a process, is crucial to include in the time of the whole process. (Bradley 2015, 141-144). In the designs, physical ergonomics was also considered in set up and closing.

Plan A was designed to the commissioner for this research as the lower cost alternative. It included designated workflow and optimized units in shelving and working surfaces. The design was motivated by improving the physical ergonomics of the workers. The issues that had arisen from the current layout in physical ergonomics perspective was one-sided work and uneven work.

The design included optimal placements for parcels, items and tools to be used in all of the phases in the physical order to cash process in the commissioner's warehouse. The design aimed to reduce the gathering phases from the current layout. The Plan A also was designed in way that workflow would not be interrupted even when multiple workers would be working on different phases of the physical order to cash process.

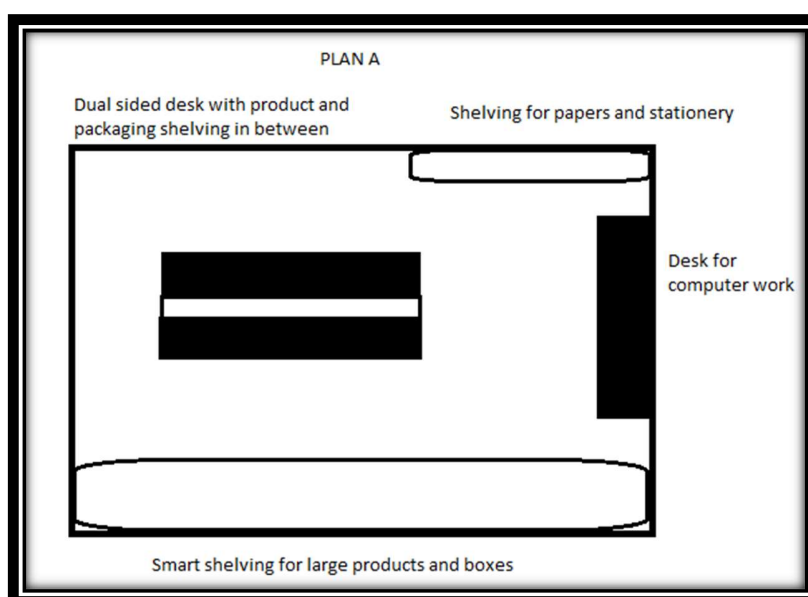


Figure 10. Living Lab: Plan A (Salo 2021)

The Plan B in the Living Lab was designed as the higher cost option. A custom build unit which is a large construction with optimized placing for each item needed in the physical order processing. The custom build has storage for small and large items, interactable desk space and designated places for tools needed in the process. All aspects were designed physical ergonomics in mind also aimed to serve workers of different heights.

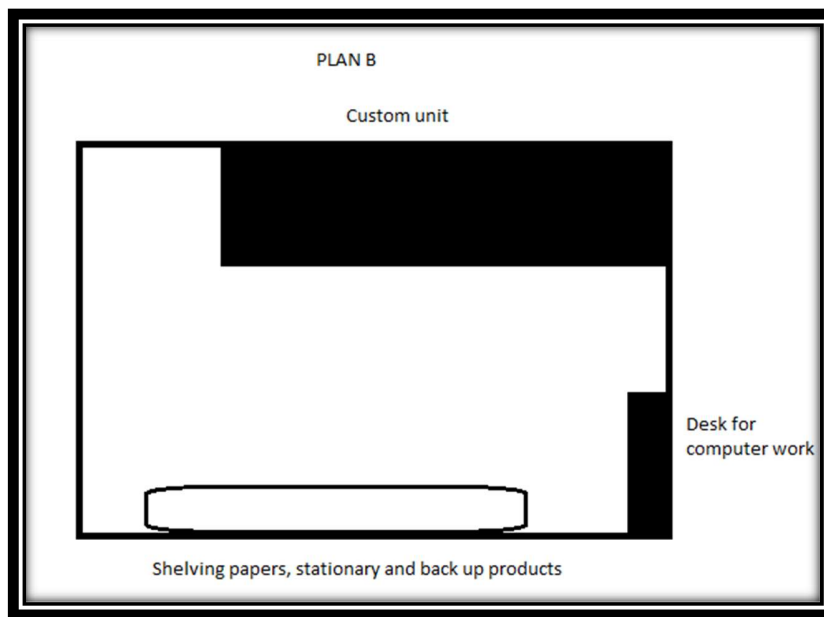


Figure 11. Living Lab: Plan B (Salo 2021)

The Plan B custom unit's final costs would have differed depending on the commissioner's texture desires and were not offered to the commissioner aside from the original plan. The cost would have been in the thousands with numerous sections and power driver features. The Plan was left as the disposal of the commissioner.

#### **4 RESULTS AND OPTIMAL PHYSICAL ORDER TO CASH PROCESS FOR THE COMMISSIONER**

The results of the Living Lab testing are presented below. The results include conjoined and separated orders with the three different variables of the Living Lab. The actual timed tests of the Living Lab were conducted 5 times on separate days. Partly due to the fact since when you are being timed, the actual processes are more rigid and getting comfortable and working as usual takes more time.

Also, since different personnel work at different paces and the timed tests were supposed to represent the actual work pace of the existing workers. The timing on the results were the average time of everyone's times.

The results of the timed tests were evaluated based on the numerical data. No other evaluation method for the physical timed tests were used. Criteria for the designed the Living Lab included in the physical order to cash process as a whole. Physical order to cash process with the commissioner includes set up and closing times in each variable.



## LIVING LAB TIMING RESULTS

For 10 conjoined orders			
	Current	Plan A	Plan B
Set up time	0:01:46	0:01:15	0:00:10
Average order fulfillment time	0:00:53	0:00:39	0:00:19
Close up time	0:02:01	0:01:31	0:00:15
Complete order fulfillment time	0:12:37	0:09:16	0:03:35

For 30 conjoined orders			
	Current	Plan A	Plan B
Set up time	0:01:46	0:01:15	0:00:10
Average order fulfillment time	0:00:53	0:00:39	0:00:19
Close up time	0:02:01	0:01:31	0:00:15
Complete order fulfillment time	0:30:17	0:22:16	0:09:55

For 60 conjoined orders			
	Current	Plan A	Plan B
Set up time each morning	0:01:46	0:01:15	0:00:10
Average order fulfillment time	0:00:53	0:00:39	0:00:19
Close up time	0:02:01	0:01:31	0:00:15
Complete order fulfillment time	0:56:47	0:41:46	0:19:25

For 6 x 10 separate orders			
	Current	Plan A	Plan B
Set up time	0:01:46	0:01:15	0:00:10
Average order fulfillment time	0:00:53	0:00:39	0:00:19
Close up time	0:02:01	0:01:31	0:00:15
Complete fulfillment time	1:15:42	0:55:36	0:21:30

Table 1. Timing results of the Living Lab testing (Salo 2020)

The 4 different segmentations were calculated as possibilities for the company on a daily basis. The knowledge of separate or conjoined work wanted to be established, so the workflow could be arranged more efficiently. The workflow could be coordinated according to delivery and pick up times, which occur in the afternoons.

Physical ergonomic results were as designed in the Living Lab, one sided work was reduced as a result of optimizing packaging, product and tool placements.

The aim regarding physical ergonomics was compared to figure 4 which presented the current state of workers physical ergonomics positioning. The aim was to make all of the order processing phases more round and more versatile instead of one sided.

Peak hour reduction depends on the total order amount for each day, therefore there are no direct results on flattening the curve as per figure 2 presented in the research. As part of the recommendations more conjoined orders was recommended for the morning time and this might help with the afternoon not being rushed if, for example customers place their orders in the evenings.

As the research was focused on optimizing the physical order to cash process using the Living Lab methodology, after the timed test and recommendations no further follow up occurred. The planned timing segmentations were successful as they show significant differences in the results and are adequate reflections on the daily orders and processing amount in the commissioner.

While optimizing any process it is important to listen and value all member in the process chain from top level to lower-level employees. This way the optimized process is more likely to work in all employee levels. When it comes to operational work, it is imperative to examine and listen to the actual floor workers for the work to be achieved. (Robertson et ell. 2021, 11-13).

Based on the results from the Living Lab and also the company's financial situation, the most optimal physical order to cash process for the commissioner was determined to be the Plan A from the Living Lab design. Plan A was the lower cost alternative compared to the Plan B which was the custom-built unit. Plan A included designated placement for items and workflow.

With Plan A commissioner is able to better workers physical ergonomics, reduce one sided work and reduce meaningless parts of the physical order to cash process with smarter product and tool placements. The gathering phases from

the current physical order to cash process were able to be eradicated in the Plan A.

Physical order to cash process with the Plan A is more efficient and workers are able to work uninterrupted regardless of what phase they are in the order to cash process as the processes flow and item placement is designed to work with several workers in different phases. The workflow design accommodates workers working simultaneously and in different phases of the physical order to cash process.

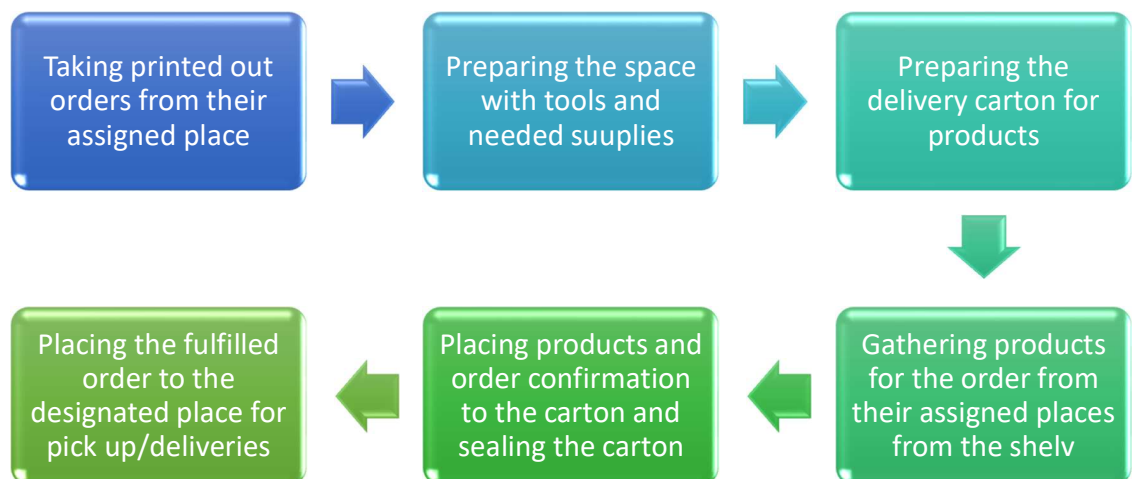


Figure 12. Optimal physical order to cash process (Salo 2021)

The optimal order to cash process is a streamlined version of the current process with emphasis on physical ergonomics and optimal item placement. The rotation flow is optimized for slower days and for peak season with several workers working on different phases on the process line. This design makes workflow a constant.

With the optimized physical order to cash process the commissioner is able to work more ergonomically while fulfilling orders and more efficiently. Also space in the warehouse was opened up for other possible functions. The space for other

customer service work on the computers was freed up more with the Plan A as a side product.

## **5 CONCLUSIONS AND RECOMMENDATIONS**

The commissioner and their physical order to cash process prior to this research had unnecessary and repetitive steps. The process was optimized using the Living Lab methodology. With minimal monetary investment the commissioner can utilize ergonomically improved order to cash process which also takes less of the employees' time when completing the physical order to cash process.

As known the Living Lab differed vastly with the current space layout and the custom made built. One of the reasons of using Living Lab as a co-creation method was to determine whether the custom build unit would be worth its buying and building costs. This depends on the total amount of orders for the commissioner. It is unknown when would the value of the custom build unit be covered by the outbound invoicing and there for it wasn't recommended. Optimal physical order to cash process can be achieved with the Plan A, the low-cost alternative within the Living Lab variables.

The commissioner also needed to consider the pros and cons of investing capital onto some furniture. Peak times do occur in the industry, yet customers behavior is an unknown factor as consumers might purchase more from events than online in the future where the physical order to cash processing occurs on site instead of the commissioner warehouse and the process is led demanding as the employee simply bags the products while cashing the customer. The cost of labor versus the time spent on physical order processing is something that the commissioner should outweigh.

The time saved by merely conjoining order was a surprisingly more significant, than anticipated in the Living Lab planning phase. With the time spent less on set up and close up times, the physical order processing times decreased significantly. This aspect also slightly improves the overall physical ergonomics,

as set and close up included lifting and one sided movement in the current layout in the commissioner.

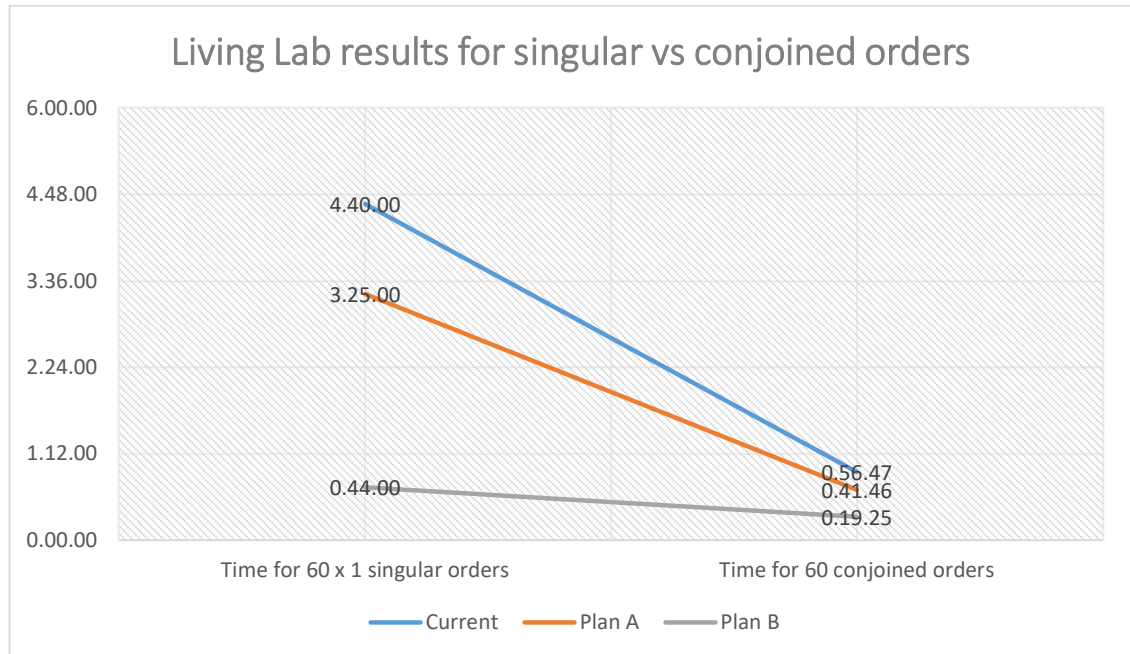


Figure 13. Living Lab results for singular vs conjoined orders (Salo 2021)

With calculations of 60x1 singular orders vs 60 conjoined daily orders the time saved with the current layout is significant and the commissioner would save much time weekly with only doing this change in their physical order to cash process. This freed time could be used for example for marketing, possible adventuring into B2B sales or bookkeeping. The recommendation includes the aspect that the work should be made only for conjoined orders, with the estimated time ending at the same time as the daily post pickup/delivery times are.

The great difference between the conjoined orders vs the separate ones was unexpected. Even with making that change, of only processing conjoined orders, which does not cost the company money, time would be saved. Continuing using the current layout with the change of conjoined orders would not improve physical ergonomics or optimize the physical order to cash process. It would merely save time for the commissioner. As the basis of the research was to optimize the

physical order to cash process, merely conjoining orders with the current layout was not recommended to the commissioner.

With the result of the Living Lab, there could be numerous approaches the commissioner could take, the most optimal and most efficient physically and ergonomically wise was chosen to be recommended to the commissioner. The full recommendation was to conjoin orders and change the physical layout according to Plan A from the Living Lab. The purchase costs and ease of transfer, with the future of the commissioner remaining unknown, the recommendation was made in mind.

The Living Lab Plan A was superior in accommodating numerous workers with the designated workflow design, where as the Plan B would had been more optimal if the preface was for one floor worker a day. As the future of the commissioner remains unknown and the current floor worker situation is above 1 the Plan B would have been optimal even if the building and purchasing costs would had been justified.

## **5.1 Key findings**

The Plan A vs the Plan B when only looking at the conjoined orders; the difference time wise is not enormous, but percentage wise it is more than double. Due to this, as a long-term decision the custom build would save a significant amount of time. Yet as daily order amounts remain unknown for the future, it is risky to evaluate, when would the cost of the custom build pay off. Especially as the commissioner operates in a niche industry, uncertainty plays a role.

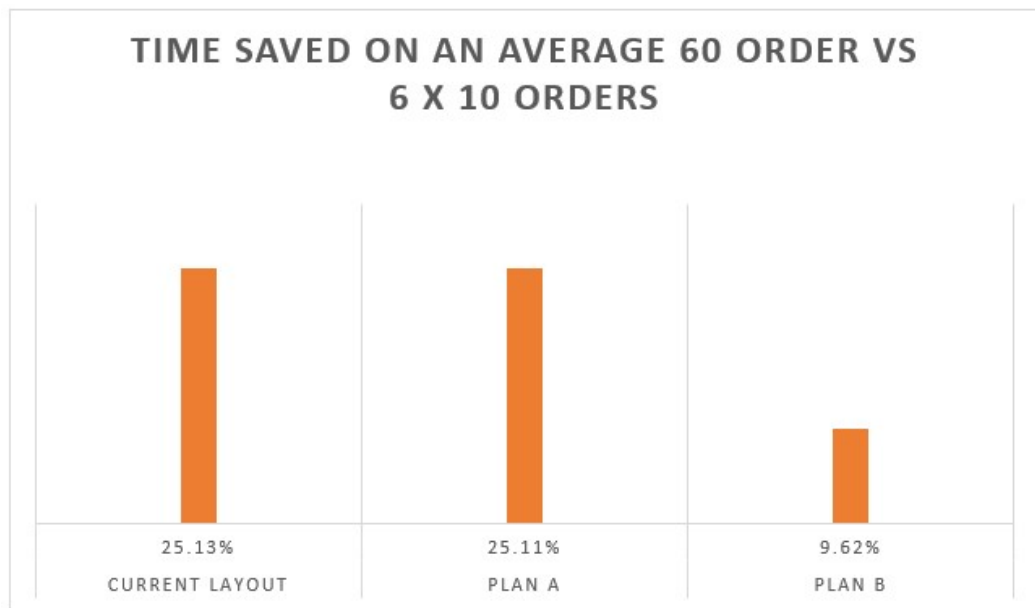


Figure 14. Time saved on an order cycle (Salo 2021)

When examining the orders that are processed conjoined vs separated the time difference is significant and, even that change in the physical order processing would save time for the workers. As the commissioner forecast based structure is MSS, which is the most viable one for a company such as the commissioner, the difference in the order to cash process timing, is in the conjoined vs separated orders despite the layout differences. (Weele 2002, 212-213).

One of the key findings was visibly finding that, when applying the VIEW test, the emphasis on workability was introduced, with physical ergonomics the one-sided work was reduced, and the work was more centered and multifaced. (Albaum et al.2005, 407-408). Optimizing the physical order to cash process numerous aspects ought to be considered in order to truly accumulate optimization.

Within the VIEW tests decision areas in physical distribution: warehousing; materials handling; carrying inventory; and order processing were optimized. The commissioner was given the Living Lab results and managerial implications and suggestions with zero, to low, to significant monetary value at the point of purchasing/implementing. (Albaum et al.2005, 580-581).

The key findings and the research would have been significantly different if the

conjoined vs separated orders was not thought out in the planning phases of the Living Lab. This furthermore emphasizes that the statement of the Living Lab doesn't give answers to questions you didn't though out to ask for. Singular order to cash process might be the prevalent thought in small to medium enterprises and therefore the commissioner hadn't considered the possible difference in conjoining the orders. Conjoining the order was the researcher's idea during the planning phases of the Living Lab. During the planning or the research conjoining orders in physical order to cash processes did not appear in studied literature.

## 5.2 Managerial implications

As the future of the company is unknown and investing money in a custom build furniture would be a big investment. Merely fulfilling orders conjointly instead of processing separated orders throughout the day, time would be saved for other tasks. Based on the Living Lab, a significant increase in orders would be required in order to save the money in labor costs vs the cost of the custom build furniture. Therefore, recommendation in optimizing the current physical space with Plan A for the physical order to cash process was in place.

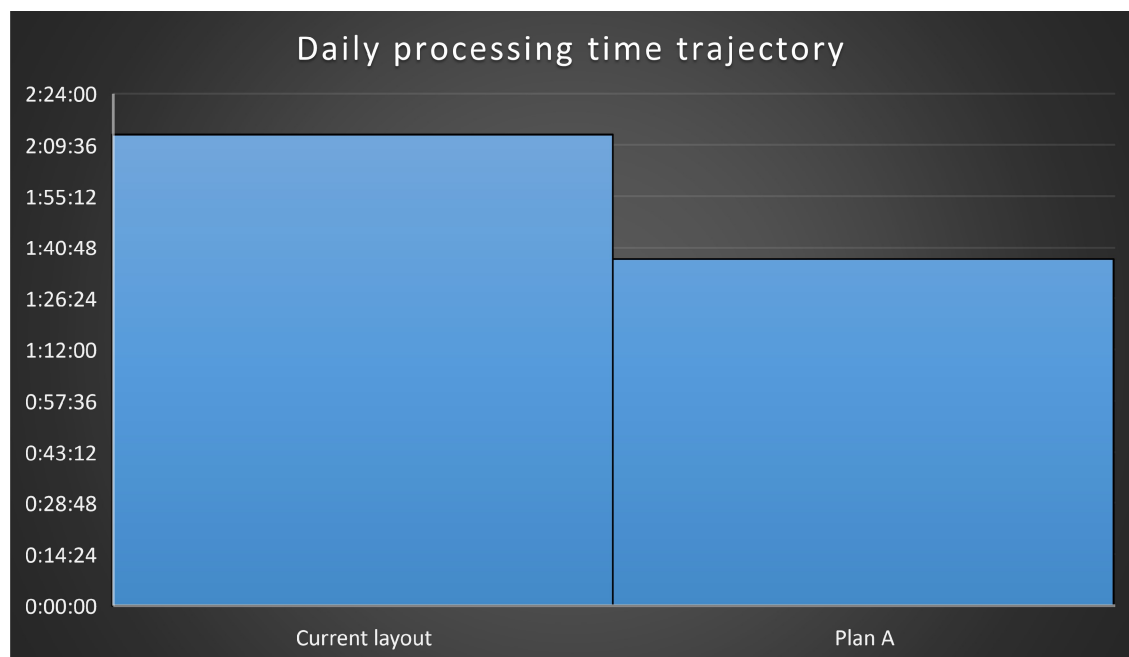


Figure 15. Processing time trajectory (Salo 2021)



With using the daily processing time trajectory

- a worker would spend processing 120 daily orders as follows compared to current layout and Plan A.
- Physical processing would be done by 60 conjoined in the morning and
- 6 X10 separated orders through the day.
  - By limiting the number of orders that should be processed as once, gives the worker a chance to focus on other tasks and make the flow of the day more fluent, and timely mannered.

Purchasing process model and its administrative organization can be optimized when making more clear processes for the workers especially regarding product and tool placement and working on conjoined orders. (Weele 2002, 35-36). Both Plan A and Plan B had clear processes and clear placements for tools and items needed in the physical order to cash process in the commissioner.

The utilization of the market intelligence cycle remains important for the commissioner to plan out. (Hedin et al. 2014, 78-79). The overall suggestion from the research was multiphase.

- With a mere rule of conjoining orders before processing them, time can be saved – yet this would not be an optimized decision and is not recommended.
- If utilizing Plan A, approximately one day of work would be required for completing the needed changes for the physical warehouse in order for it to be sufficient with minimal monetary need.
- Managing workers day more sufficiently with physical order processing considered to only being one the needed processes which are done daily.
- Implementing data collection of conjoined orders in order to collect the needed data of the physical order to cash processing.

The success factors in purchasing departments and physical order to cash processes can be optimized in regarding easy access and prompt delivery when implementing the Plan A, with the conjoined order processing presented in the

Living Lab. (Weele 2002, 328). Merely conjoining orders with current layout, the process would not be optimized. The physical order to cash process would be only concluded faster. With the implementation of Plan A the physical order to cash process would be optimal for one or more workers working on different phases of the process.

### **5.3 Further research**

The research conducted was for a small single platform entity. Living Labs might be more common for bigger public entities when researching for cases such as in construction cases as in Helsinki. (SRV 2017). The researcher would also be interested in seeing Living Lab utilized more in a commercial setting as it would interesting with the methodology's potential for increased inclusivity with customers. With today's world and social media access and communication with different entities and companies I would see this as a continuation in the future.

The research validated the usage of the Living Lab methodology more within companies and their physical processes. As the commissioner was a single platform establishment, the key findings would benefit a larger scale implementation. Conducting a case study on a larger scale would be intriguing. Singular and larger scale research in supply chain are different from each other with different optimization techniques. (Cole 2014, 33-34). Would the key findings within separated and conjoined order processing be as significant as in this small-scale research?

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- Figure 14. Time saved on an order cycle (Salo 2021)
- Figure 15. Processing time trajectory (Salo 2021)