

OUTBOUND PACKING PROCESS REPORT

 Bolton Fulfilment Centre

SCHULICH SCHOOL OF BUSINESS, OMIS 5210 S

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Table of Contents

Executive Summary:.....	2
Introduction:	3
Process Overview:.....	4
Key Issues & Bottlenecks:	5
Data Analysis	5
Insights	6
Bottlenecks	7
Recommendations:	8
Conclusion:.....	9
Appendix A	10
Appendix B	10
Appendix C	11
Appendix D	12
Bibliography:	12
TCPS 2 Certification and Consent Form:	13

Executive Summary:

Amazon is one of the largest e-commerce providers in the world. In order to maintain its dominance in the online market, it requires a parallel network of distribution centers to manage its day to day operations. Although Amazon's distribution network consists of multiple different centers, but for our analysis, we will be focusing on its fulfillment centers that manage the bulk of the orders. A fulfillment center is responsible for storing and managing inventory, sorting and packing orders, and finally dispatching the orders to the intended customers. The part of this process that we have identified that could use the most improvement hence worthy of further analysis is sorting and packaging.

The report conducts a comprehensive study of this process, identifying key pain points. Furthermore, it aims to highlight the different bottlenecks that may exist and provides relevant and useful recommendations. The information used in the analysis is based on firsthand insight gained from an individual working within the fulfillment center. Furthermore, the quantitative data in our analysis has been collected and used with permission from Amazon and its employees for the purpose of this study. The insights obtained from the interview with the individual reflect operational hindrances as well as the individual's personal observations. The described packaging process includes the complete pathway of the order item from the inventory area until the dispatch of the packed item. In the report certain bottlenecks and key issues are identified and analyzed with a focus of exhaustive implications for the company. For ease of comprehension, certain assumptions are made to simplify the process for study purposes. These include treating the production process in terms of batches, rather than the actual continuous process. It enables us to quantify the process and present our findings in a structured manner. Furthermore, provided recommendations are solely for study purposes only and may require additional data and analysis before implementation.

The purpose of this report is to provide implementable and relevant recommendations to improve on Amazon's already highly efficient operational process. The proposition takes into consideration Amazon's reluctance in making drastic changes. First recommendation involves creating a buffer system at different steps of the process to minimize the risk of complete stoppage, which according to our research causes the most amount of damage to the operations. The second recommendation revolves around the fact that human errors still account for the majority of mistakes made in the process. Therefore, to mitigate the human error aspect from the process, we recommend implementing visual clues for guidance purposes.

This report recognizes the almost perfect operations that Amazon runs in its fulfillment centers. Furthermore, keeping in mind their rigidity towards change, our recommendation aims to make subtle yet effective changes that can improve the processes throughput rate and hence its overall productivity.

Introduction:

Amazon is one of the largest e-commerce providers, not only in north America but now around the world. Apart from the e-commerce market, it has established roots in other markets such as cloud computing, with its AWS division, the grocery retail market with the acquisition of Whole Foods Market and Artificial Intelligence backed by its Alexa powered Echo devices. Established in 1994 by Jeffrey Preston Bezos, Amazon has enjoyed exceptional growth with the company now worth over \$1 trillion (Vlastelica, 2020) and operations in over thirteen countries (Megson, 2019). But the majority of Amazon's business and operations revolves around its core business of e-commerce.

Since its inception, the company has been able to establish a massive distribution network to complement its online sales portal. This distribution network includes Crossdock Centers, Sortation Centers, Delivery Stations, Prime Now Hubs, Prime Air Hub & most importantly Fulfillment Centers. These Fulfillment Centers or FC as they are commonly known are the lifeblood of the organization. Comprising of over 150 million square feet of space and employing hundreds and thousands of individuals (Amazon Inc., 2020). The fundamental work that happens at these Fulfillment Centers includes unpacking and inspecting incoming goods, storing these good while recording their location, picking ordered goods form their storage point, sorting & packing the ordered goods and dispatching for delivery.

Although each part of the process holds importance and is worthy of analysis, but the sorting & packing process dictates the overall efficiency, capacity and the quality of the work that takes place at these Fulfillment Centers. Therefore, our analysis would consist of overviewing the process, identifying the key issues and bottlenecks, and providing our recommendation on how to improve the efficiency and quality of the process. Our information is based on firsthand insights gained from individuals working on this process and the quantitative data in our analysis has been collected & used with permission from Amazon and its employees for the purpose of this study.

The clients, of this particular process and the overall distribution process as a whole, are the individuals who order products online using amazon's website and application. Products offered by Amazon to these customers range from a variety of categories, from consumer electronics to apparel & from home appliances to furniture. Regardless of the size, weight and nature of the product, they have to pass through one3 of Amazon's Fulfillment Centers. In essence, the Fulfillment Center provides a service of efficiently dealing with the orders in a timely manner with minimal errors and dispatching these orders to the next step in the process, which is delivery. These products could be from Amazon's own inventory or some third-party suppliers. External suppliers hold no control over the processes that take place at the Fulfillment Center as Amazon holds either of the two kind of inventories collectively in their warehouse. Therefore, the process of sorting and packing is not in any way impacted by external suppliers. Quality is measured by the accuracy and, the efficient and timely execution of the order. Cost is primarily impacted by the number of individuals working at this process and the packing material used in each order. Speed and efficiency are measured by how fast an order can be processed, from start to finish, while maintaining the criteria for quality. Lastly, the capacity of this process is measured by the

total number of orders that can be handled through the Fulfillment Center and this sorting & packing process in particular.

Process Overview:

The Amazon warehouse, also known within the company as the fulfillment center, is the “heartbeat” behind the company’s massive operations. Most of these fulfillment centers are operationally standardized and function uniformly. They enable Amazon to scale up or scale down in response to changes in demand. (Wohlsen, 2014)

The packing process starts with Amazon’s warehouse “pickers”, associates who work in the area where inventory items are stored. The items are picked, scanned and placed into totes by associates. At times different products of the same order may be picked up by different pickers. There are two picking methods used in the fulfillment centers of Amazon: piece picking and zone picking. Scanners or “pick mods” guide associates to the items. Once totes are filled, they travel to the pre-packing stations where associates sort the orders and split the totes. At this stage, associates split the orders amongst single item orders, multiple item orders and small products so that these orders will suit specific packing conveyors. Upon completion of the split stage, orders are sent and placed on conveyors. There are three types of conveyors: single package, multi package and smart package. Locations of these conveyors are different and therefore, the split process enables not only the technical aspects of the packaging but also the logistical aspects. Multi packaging conveyor is the closest to the pre-packing station, however before multi order totes placed on this conveyor they go through additional sub-process called “re-binning”. In this process multi orders are placed in a giant cart with bins that separate each multi order. After that the giant cart is moved by an associate towards the multiple packaging conveyor line. Smart and single orders do not require this re-binning stage as these items are directly placed to the conveyors for packaging.

This report considers and analyzes the process from the point when items reach the conveyor belts until the quality check stage called “kick off”. All prior stages (i.e. picking, splitting and re-binning) are not considered in this report’s quantitative methodology.

All items then move towards the packaging station where associates pack the orders. In this part, a box suggestion system designates the appropriate size of the box for the order based on the dimensions of the product and makes recommendations to the associate. The associate picks the recommended box and proceeds with packing the order. All associates are trained extensively in packaging techniques; however, during the application of these techniques there are variations in working pace of the associates. Though the process of box packaging is very standardized, our research shows that implementation of the standard method varies amongst packing associates. This in turn creates variation in the average packaging rate per associate and the lead time of the overall process. The next stage in the process is called “slam” where boxes packed by the associates proceed to areas where shipping labels are printed and applied on them. The name of this stage comes from the four actions taken within the process: scan, label, apply, manifest.

The last stage of the process before shipping of the orders is the “kick off”, evaluation of the packaging. In this stage packages are scanned by a computer to measure

the dimensions and weight against the packing label. Software checks for quality of the packaging with build-in evaluation criteria. If there are any discrepancies in the package, it is 'kicked-off' to undergo the entire process again. Then labeled packages proceed to shipping station where associates load packed boxes for delivery. This concludes the overview of the packing process.

This report considers one shelf as one batch. Though Amazon's packaging is an ongoing "one-piece flow" process, for the sake of analysis and clarification, this report considers that a batch consists of 24 items with an equal split of 8 multis, singles and smarts. One batch is ready in as low as 392 seconds which includes the processes of packing, printing and labelling (see in appendix A). The critical path is the path on the process diagram that does not have any slack. In this case the critical path is through the multi packaging segment (See Appendix D). The network diagram shows the process up till the shipping stage.

Key Issues & Bottlenecks:

Data Analysis

Through the interview, it has been determined that the actual packing process has a range of sub-process times in which it is completed as the associates can vary in their speeds as well as the complexity of the order at hand. For the multi packing orders, the process time can vary between as low as 45 seconds to as high as 75 seconds for more complex packaging. A sub-process time range of 25 to 40 seconds is considered normal for single box packages while a smart pack (envelope-style packing) can be done in as low as 15 seconds up to a maximum of 20 seconds. Though these time ranges may seem to be a possible metric which can be used to track the efficiency of the operations line, Amazon uses UPH or units per hour as a prime metric throughout the process. The data for the sub-process times is shown in the table 1 (See Appendix A).

The sub-process times given are for one associate and not for the entire packing area at the fulfilment centre. The average packing speed data has been gathered from the SPOC while the time range has been the informal range estimation provided through workers on the line. Two sources of data were used to validate the accuracy of the information being provided. The averages from the time range are similar to the data given from the SPOC and hence were determined to be accurate to use for further analysis.

The sorting phase takes approximately 15 minutes to fill one shelf before it is sent down the line while the printing and label phase, also known as the slam process, is fully automated and hence has a fixed process time of 5 seconds per package. These printers actually print and stamp two packages at one time and hence have a cycle time of 2.5 seconds. No information regarding the time between each activity could be found and hence is not included in any analysis or calculation. For simplification purposes, this analysis reduces the process to a single batch of 24 orders, with an even split in the type of packing required as mentioned in the process description section.

As the packages are split into three conveyors, we can use the maximum and minimum sub-process times to find the overall packing rate which is shown in the table

below. As no information could be retrieved regarding the exact number of stations on each conveyor, it is assumed that the three conveyors have the same number of stations for ease of calculation and figure 1 (See appendix B) shows the output to the printing stage as a function of the number of stations on each conveyor.

Multiple scenarios have been created to see the correlation between the number of associates on the line to the supply. Through our SPOC, we determined that the Bolton Fulfilment centre has a monthly throughput of between 5 and 6 million packages. The split of these packages could not be determined; hence an assumption of an equal split is being taken. With this data, we estimate that the fulfilment centre incorporates at least 16 stations on conveyors to meet the 5 million a month mark and up to 20 stations per conveyor to meet the 6 million mark. As the packing is seasonal due to customer trends changing over the year, this throughput figure is the average quoted by the SPOC.

The printers being used in the process have a rated capacity of 1800 UPH (information through SPOC), thus we can calculate that for, approximately, every addition of 4 stations per conveyor, or a total of 12 new associates, a new printer would be required to be purchased or activated to not form a bottleneck in the slam process and purchase/activation of additional printers below this amount would reduce the utilization rate which can be seen in figure 2(See Appendix B), which shows the estimated utilisation rate of printers from the data given. The actual throughput rate of the process would realistically dictate the purchase/activation of a new printer, but that rate is in-turn affected by the packing associates and workstations on the conveyor.

Insights

After analysing the packaging process of the Amazon's fulfilment centre, it is important to highlight a few important insights in this report. While the Bolton warehouse ships out 5 to 6 million packages a month on an average, this number may be higher with seasonality especially during the holidays. The maximum capacity is still difficult to determine as this information is not accessible. The packing stage in the process heavily depends on human labour and sometimes mistakes do happen. For instance, if an associate, in any circumstance, is unable to pack an item in dedicated time the entire conveyor would have to be stopped to catch up with the packing. The disruption of the process does not take longer than a few seconds, however while calculating the process time in seconds, it makes a large impact on the overall lead times. It impacts the entire conveyor downstream. Though this doesn't happen so often, it is still considered one of the weakest sections in the process. People, material and information have to "wait" in the process if this kind of situation appears. In 2019, Amazon had an idea to test the initiative of replacing human packers with machines. The Italian firm CMC Srl produced packing machines which pack four or five times faster than humans. These machines required one person to load customer orders, another to stock cardboards and glue, and one technician in case machines gets jammed. How far this initiative was realized is unknown (Dastin, 2019). The cost of labour would place a large role in determining whether such automation would be worth investing resources in.

During the interview it was clear that fulfilment centre makes trade-off between cost and quality. Amazon uses boxes and polybags in their packaging of items. On one hand

boxes reduce the kick out rate given the fact that the flat surfaces of the boxes allow the scanners to be able to read the labels with a higher success rate, but they are more expensive to transport as boxes are heavier and utilize more space in delivery trucks. Plastic bags are lighter and provide an opportunity for cost saving but do increase the rate at which scanners fail to read the labels. While it is beyond the actual packaging process we are looking at, improvements in this field could make massive impacts to the entire company.

Amazon closely interacts with its suppliers and these suppliers do impact the operations within the fulfilment centres. The inventory area directly influences the packaging process. It is important to note that Amazon maintains strong relationships with its partners, and forces suppliers to operate by its standards. Employees within the process are generally concerned about the safety, especially after recent reports showed that many injured employees were not treated well and not even covered by insurers until they opened lawsuits and won the court orders (Sainato, 2019). In the long run similar incidents might influence work culture, hence all processes in the fulfilment centre could be impacted. The packing section is most vulnerable to this owing to its high reliance on human capital. Packing section in the process requires more than just fast speed and standard actions.

After the packing process the next stage is the slam process, where a printed shipping label is applied containing all the information regarding that specific package. According to the interview, the printing stage alone has an average of 5 seconds for each shipment and each printer can only print two labels at a time. During this period there is a waiting time for each package in line for the slam process. Although this stage does not represent a bottleneck in the process, in our analyses we have identified this as a possible limitation for the process since the number of printers has a direct influence on the process flow. Apart from the number of printers, the printing rate also has a huge influence on the lead time for this stage. The variability created from the printers with different capacity generates a significant time variation in the total output. In this case a more standardized printing machine would reduce the variation and make the process more reliable.

Bottlenecks

With a complex distribution chain that serves customers globally, Amazon is known for shaping a customer experience concept that no rival has been able to match. As described in the process overview section, even though this customer-centric company provides a cutting-edge distribution process, there are still some parts of the process that present constraints in the final output. Just as any operation process, there are some stages that bring limitation to the capacity reducing the potential flow. This does not mean that the process as a whole is not capable of achieving its purpose, but that the full potential of the process is offset by specific stages.

The first bottleneck that is possible to be observed is naturally the number of workstations on each conveyor. During the interview, this point is brought up as the biggest point of limitation in the process since all the distribution flow occurs within these massive warehouses where Taylorism plays a big role in the organization. Naturally, without taking into consideration the cost, the more workstations operating globally the more efficient

Amazon will be on delivering the product to the final customer. Though a standard packing method is taught during the training of associates, many develop their own methods of packing which saves some effort while giving an end result which is similar to what the managers desire. This variation in packing leads to the kick-off rate to increase which forces packages to go through the packing process twice before heading to shipping.

The next bottleneck identified in the process is the number of workstations per conveyor in operation. As described during the interview, the packing stage is done by the associates, and the number of workstations dictates the number of associates working. The packing process is composed by the following steps: taking the order, scanning and putting it in the box. But as described in the process section, there are three different types of packing process with different time length for each one. The multi packing process is the one with the biggest variance, ranging from 45 to 75 seconds for each package. This may be explained by the complexity that comes with the packing process involving more than one product. The smart pack for smaller items that go into envelopes has a more stable time range with only 5 seconds of variation from 15 to 20 seconds, which can be explained by the fact that this is a less complex process. This way, as any human interaction, there are some variations on the productivity. The number of working stations is identified as the second bottleneck in this process since its variations in associate efficiencies represent a huge difference in the final picture. When considering the total amount of packages for a whole day in each of the warehouses operated by Amazon this would generate a huge time loss. We can conclude that the lack of management control towards a more standardized packing process being followed results in a time variation that, in big proportions, creates a big loss of productivity coupled with the number of active workstations result in some productivity loss in the process.

Recommendations:

Figure 3 (See appendix C) shows a visualization of the human aspect within a relatively well-oiled machine we know as Amazon. It is evident that the single and smart packing has a much lower tolerance as the time range is 15 and 5 seconds respectively. The outlier is the multi packing. The range for this sub process has a range of 30 seconds which compared to the other processes is much larger. As discussed in previous sections of this report, the multi item conveyor is the critical path of the process and cannot be delayed. It has no slack and any stoppage on the multi conveyor can cause the entire process lead time to increase.

The variation in the packing time on one of the conveyors can create a pile up in the re-binning or sorting phase, drastically lowering the efficiency of the entire packing process. This could be resolved through the use of longer conveyor belts or helical conveyors which do not use as much floor space as conventional conveyor belts. The use of such a solution would create a buffer to absorb some of the slowdowns and not stop or disrupt the activities upstream. As mentioned before, we have looked at the packing process as a batch of 24 orders but in reality, the process is continuous without any actual batches and hence having these buffers could smoothen the flow.

Another method that can be incorporated is the poka-yoke method. This method reduces inadvertent mistakes that can be made by humans in a process through the use of

colour codes and other visual clues. As a large portion of the process relies on human interaction, a colour-coded bin system for the multi conveyor could help reduce errors. Bins can be coloured to show a range of items such as 1 to 5, 5-8 and 8 & above so that packing associates know how many items need to be packed. This could help reduce the number of errors which go through the kick-off phase by not wasting time packing items which would not pass the quality check at the end. Additionally, associates that are doing the re-binning would get another visual clue while putting items in the bins as may perhaps reduce errors in the re-binning stage as well. The actual implementation of this system could be challenging but is a low capital operational change.

Through the interview conducted, we found out that amazon does not make drastic changes within its systems as they have created a highly efficient system but are always working on smaller changes within them to improve the efficiency and more importantly reduce the error rate. Amazon is a six-sigma company and have stayed below the 3.4 errors per million opportunities but still have a culture of making continuous improvements wherever possible.

The recommendations provided here are quite general as access to Amazon's data has been limited, which is why an implementation plan has not been created but some opportunities have been identified to reduce the variation in the process and perhaps lead to reduced errors in the outbound packaging process at Amazon's Bolton fulfilment centre.

Conclusion:

Amazon runs a tight ship in all its operational processes. Through continuous improvement, it has been able to highly refine its methods and processes. This evolution has resulted in minimal rate of errors and highest degree of efficiency in its fulfillment centers. Through our analysis, of the packing process, we were able to highlight the key bottlenecks that either limit the capacity of the process or poses potential threats of delays.

Due to the highly efficient system being run at these fulfillment centers, coupled with Amazon's reluctance towards making drastic changes to their system, the recommendation being made needed to be subtle yet effective at improving the process. The first recommendation consisted of creating buffers along the different steps in the line, to mitigate the risk of pileups and hence a stoppage in the production lines, in the case of any issue. The second recommendation revolves around the possibility of human error. It involves the implementation of practices that provide visual clues in order to minimize the possibility of human errors.

We believe that through the implementation of our recommendations, Amazon will be able to further improve its packing process. These easy to implement changes would subtly minimize the chances of errors and the possibility of total closure. Thereby increasing the processes throughput rate and hence productivity.

Appendix A

Table 1 - Sub-process times

Order Type	Average Packing Capacity (per associate)	Packing sub-process Time (in seconds)		Packing Speed (in UPH) per associate	
	In UPH	Fastest	Slowest	High	Low
Multi	60	45	75	80	48
Single	120	25	40	144	90
Smart	220	15	20	240	180

Table 2 - Timings for the printing sub-process

Printing Phase		
Capacity (In UPH)	Process Time (in seconds)	Cycle Time (in seconds)
1800	5	2.5

Appendix B

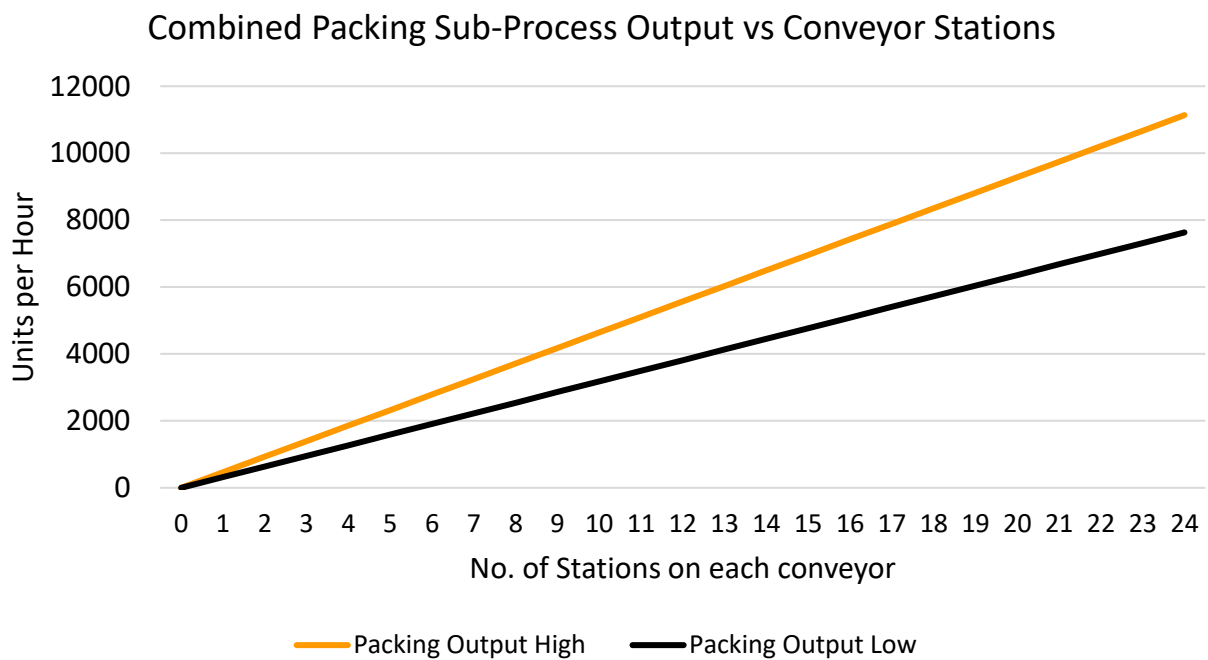


Figure 1- Packing sub-process output as a function of no. of workstations per conveyor

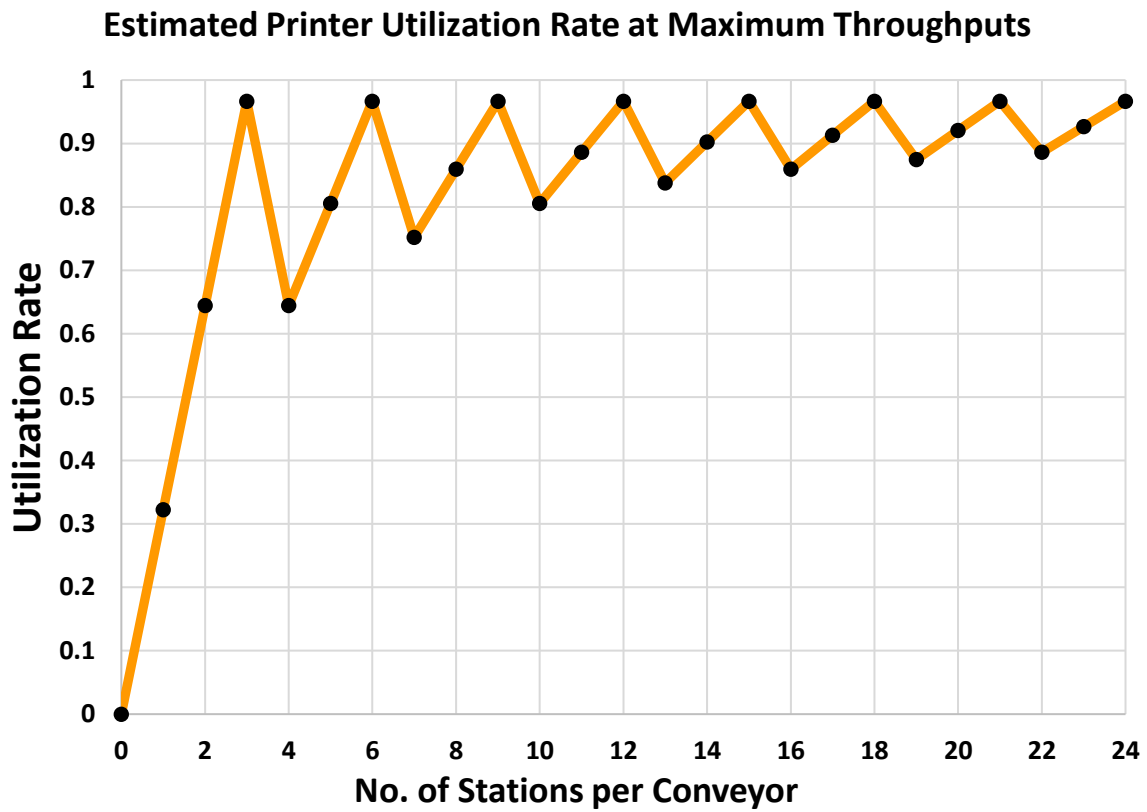


Figure 2- Estimated Printer Utilization Rate

Appendix C

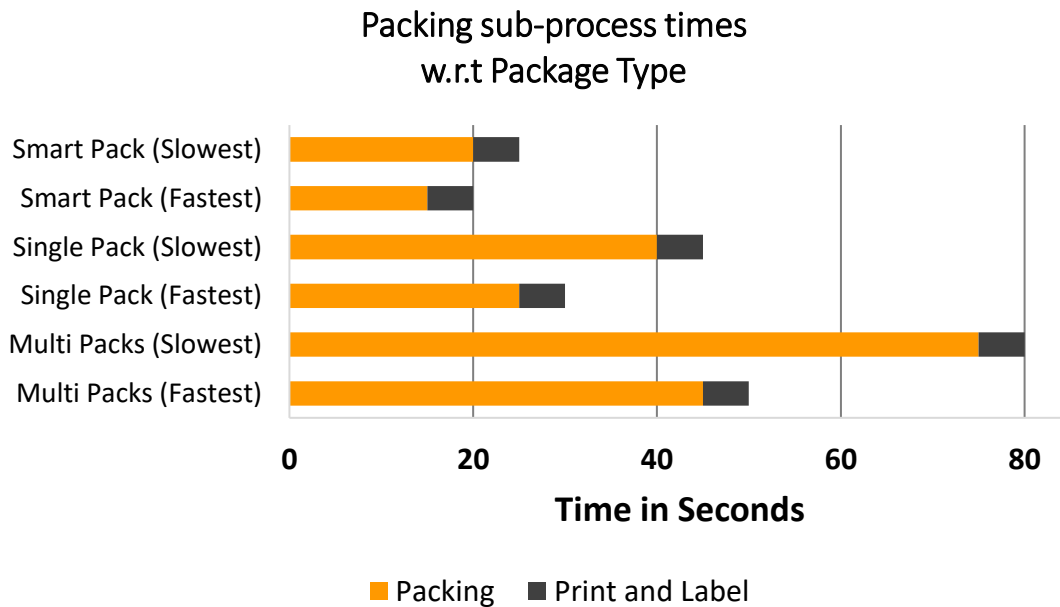


Figure 3- Packing sub-process times

Appendix D

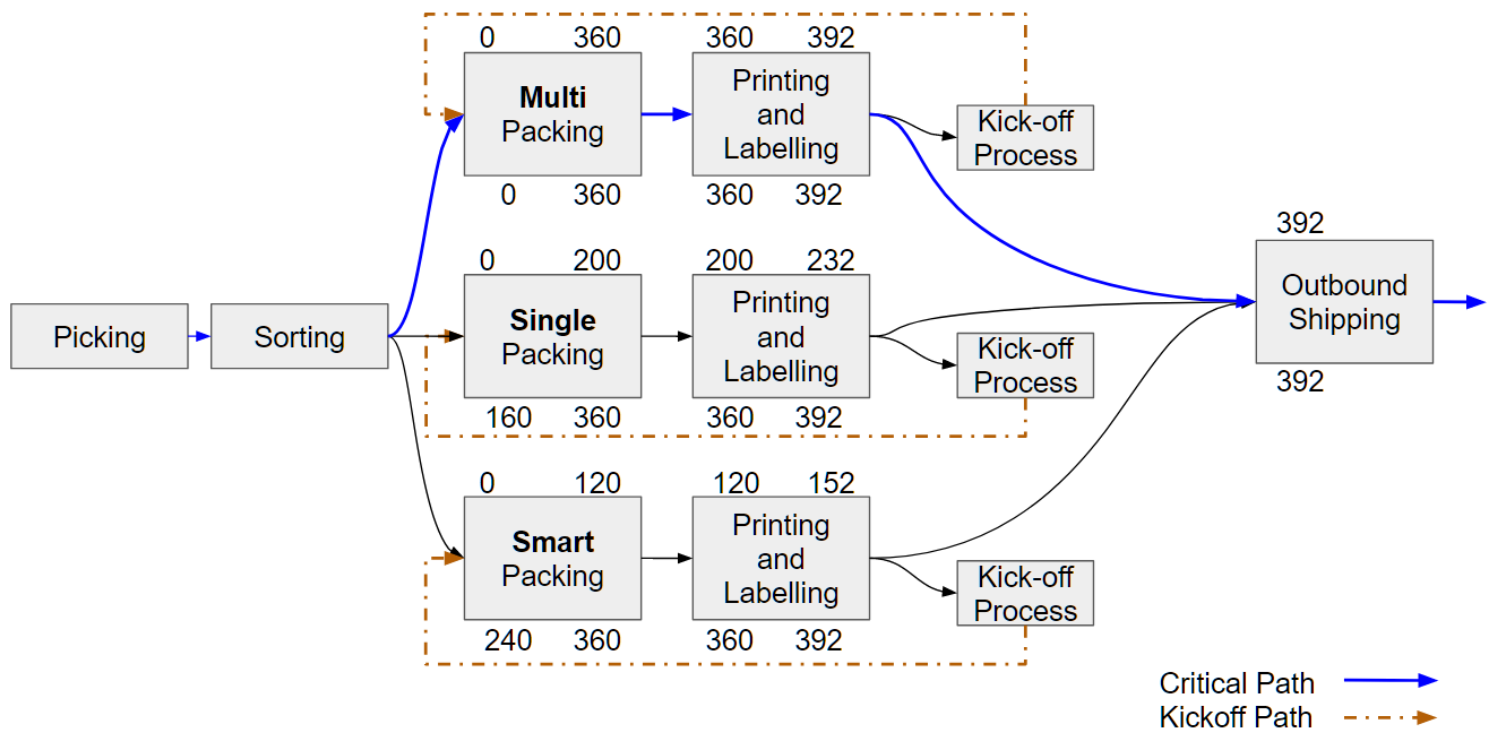


Figure 4 - Process Diagram with ES, EF, LS and LF

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TCPS 2 Certification and Consent Form:

**PANEL ON
RESEARCH ETHICS**
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Ranbir Grewal

*has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)*

Date of Issue: **20 July, 2020**

Figure 5- Certification completed prior to interview with SPOC

Schulich School of Business, York University

Informed Consent Form for In-Person Interview or Survey

My name is (*student, please complete*) **Ranbir Grewal**.

I am a student at York University in the Schulich School of Business. My contact information and that of the professor who is supervising this work is provided below. If you have any questions about this ethics review process or substance of the research please feel free to contact my professor, Dr. Linda Lakats (llakats@schulich.yorku.ca) for clarification.

My goal is to analyze a process for my final project in OMIS5210 (Operations Management), and I am interested in doing so by observing the process and asking questions about it within your organization.

I am therefore asking if you would agree to participate in my research by answering a series of questions. We will make notes of the answers for use in our final report.

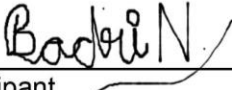
I think you may benefit from participation in this research because sometimes when we reflect back on previous experiences or collect our thoughts on a topic we can learn or understand events in a new way. If you feel uncomfortable or concerned about this please let me know and we can either not continue with the interview or reschedule at a time that is more appropriate.

Please understand that you do not have to participate in this research, and that you can terminate your participation at any time during the course of the research. Also feel free to skip any particular question and move on the next one at any time during the research. In addition, once the research is finished, you have the right to ask me to not include the information you provided in my research.

This research is confidential and no individuals or organizations will be identified without their written consent. Any information that could reveal your identity or that of your organization will be excluded from any future papers or research reports that are written based on this research. I will destroy any surveys, tapes or interview notes at the end of this project. This research has been approved by the Schulich School of Business Human Participants Review Committee.

Participant:

I am fully aware of the nature and extent of my participation in this project as stated above and the possible risks from it. I hereby agree to participate in this project. I acknowledge that I have received a copy of this consent statement.



Signature of participant

Badri Narayanan

Printed name of participant

25.07.2020

Date



Signatures of researchers