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PRODUCTION PLANNING PROCESS IMPROVEMENT: CASE STUDY FROM THE APPAREL ACCESSORIES INDUSTRY

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ABSTRACT

Alpha Lanka (Pvt) Ltd operates in the apparel accessories industry in Sri Lanka, where On-time delivery (OTD) performance is a vital factor. However, achieving OTD to the expected level, which is from 90% to 95%, has become a challenge due to the complications in the production planning process. Currently, the production planning process is done manually by using Excel spreadsheets which increases the complexity of the planning process. The aim of this study is to recommend an innovative production planning tool that enhances OTD performance while giving accurate promise dates. The scope of this work is limited to one specific product line within the company. The study adopts an exploratory research design to clarify the problem and uncover new insights. The main research approach is qualitative research since it mainly considers the subjective experiences of people. Unstructured and semi-structured interviews, focus groups, and observations have been employed as primary data collection methods, and company records have been employed as secondary data collection methods. Finally, the research used process modeling, Pareto analysis, root cause analysis, and 5 why as the techniques to analyze the data. The analysis showed that Production delays were the main cause of OTD delays. This study suggested a model of a production planning tool that was developed using spreadsheets and related process improvements to achieve a proper production planning process. The tool was developed using various functionalities and formulas of spreadsheets to streamline the production planning with estimated lead time and to organize the production planning data effectively. Overall, the study provides valuable insights into the production planning process.

Keywords: On-time delivery (OTD), Process improvements, Process mapping, Production planning, Production planning tool

1. Introduction

Alpha Lanka (Pvt) Ltd operates in the apparel accessories industry in Sri Lanka as a business-to-business (B2B) company. The company is making their production under seven main production lines. Radio Frequency Identification (RFID) production line is the focus of the study among them. Each line has a separate production planner, who works on production planning based on the customer-requested date and capacity of the machines in the line while the labor requirement is planned by either the production line manager or the team leader of each line.

A sound production planning system is the base of providing accurate and timely information related to production (Walton & Metters, 2008). Also, if any company operates with a moderate level of complexity, it needs a formal way of planning production (Walton & Metters, 2008). Alpha Lanka (Pvt) Ltd currently uses simple and basic spreadsheets as their tool for production planning. Spreadsheets are typically familiar, and more accessible, and they automatically facilitate a comfort zone for employees (Walton & Metters, 2008). The company works with diverse types of products and quantities; thus, production planning becomes challenging with limitations in the current simple and basic spreadsheet such as high error rate, difficulty in analysis, increase in the complexity of the planning process, etc.

According to information regarding the RFID, they are currently facing challenges in meeting Key Performance Indicator (KPI) targets. One of the challenging KPIs is flexibility, and it is measured from the OTD performance. Unable to meet OTDs leads to dissatisfying the customers, gaining financial penalties, and disruption of the supply chain of Alpha Lanka (Pvt) Ltd. Reliable forecasting is a more significant improvement to the OTD performance (Donderwinkel, 2015). However, RFID is not able to maintain reliable forecasting due to less visibility of the data. Customers can set the due date according to their requirements if a business maintains lead time flexibility (Wang, 2008). Currently, Alpha Lanka (Pvt) Ltd is maintaining an OTD rate of around 90%. However, their expected OTD rate is 95%.

Therefore, this study aims to recommend a model of production planning tool, that can enhance the OTD performance and recommend some process improvements to the current process. The following objectives are set based on the research problem of the study. By achieving these objectives, Alpha Lanka (Pvt) Ltd can improve its operations by delivering the products on time from a properly designed production planning process.

- Objective 1: Understand and map the current production planning process (AS-IS Process Mapping).
- Objective 2: Identify the root causes for the gaps between the expected and current performance of OTD.
- Objective 3: Suggest improvements to achieve the expected performance, in the form of a model of a production planning tool with related process improvements.

2. Literature Review

2.1. Production planning

Production planning is the act of calculating a rough estimate of how much production will occur over the following several periods (Viana & Pedroso, 2013). High-level decisions that limit production have an impact on product planning. Production is limited by fixed resources, for example, machinery and labor. However, under some circumstances, it may be possible to change personnel (through hiring, layoffs, and overtime) or the amount of equipment (through leasing) as part of the overall production plan. The production plan involves the determination by the management of resources that are fixed and variable in the intermediate period (Viana & Pedroso, 2013). When considering challenges in production planning, the following points are key.

- Demand fulfillment has a significant impact on lead times for orders as well as OTD (Garetti, 2012). OTD is a key factor in gaining competitive advantage and enhances customer service levels (Nakandala et al., 2013). Nakandala et al. (2013) present a decision support model for addressing production planning-related issues which leads to improved OTD performance.
- Managing tasks to increase output and efficiency (Handa et al., 2019).
- As the significant constraint in supply chain management, high-level objectives make the next lower-level constraints (Giglio et al., 2017).
- Producing accurate production plans for each period of the planning horizon (Hassani et al., 2019).

2.2. Approaches to overcome the production planning challenges

2.2.1. Production planning tool

Production planning requires an appropriate and effective planning tool since it affects the overall supply chain (Gastermann et al., 2014). Production planning tool supports to control of the production planning process and management of data related to production. Ivanov and Dolgui (2021) present the advantages of the computerized model such as real-time data and end-to-end visibility. Enhancing accuracy, supporting production planners to analyze, and reducing the effort of humans are some of the key benefits that manufacturing industries would obtain using production planning tools (Fritzsche et al., 2011). Production planning tools encompass the management of the manufacturing process, including materials, machinery, workforce, and more. These tools are aligned with market demands and company strategy. Production planning tools facilitate efficient material flow and resource utilization, aiding in overall operational effectiveness (Zimniak & Józefowska, 2008).

2.2.2. Skill matrix

Businesses are beginning to recognize the value of human capital and have adopted a competency-based approach to human resource management to enhance the quality of their human capital, learning, and developing trust among employees (Paritkar & Parchure, 2016). A skill matrix or training matrix is a document that is used to evaluate the competencies needed for a particular position inside an organization with the employee's current skill level (Bajpai, 2014). Maintaining the employee skills matrix database is of utmost significance, as over time, employees continue to acquire new skills for various operations and enhance their performance in existing tasks (Islam et al., 2015).

2.2.3. Improvements in the process

The main goals of process improvement are to recognize, assess, and enhance business processes. This comprises raising quality, cutting waste, and maintaining gains. Chang et al. (2012) showed improvement in the performance of production planning procedures using the business process improvement method of Six Sigma. In large manufacturing facilities, it can be challenging to implement process improvement initiatives across various work areas. Furthermore, resource allocation problems related to multiple competing projects regularly plague large organizations (Chung & Hsu, 2010). It might be challenging to decide where to begin when implementing process improvement initiatives due to the availability of numerous production functions with various production activities and various products. While each team member has a different starting point preference, they all have different reasoning (Fazeli & Peng, 2021). The 5-Why method, Pareto Charts, and Cause and Effect diagrams are all valuable tools in problem-solving and process improvement initiatives. The 5 Why method uncovers root causes by repeatedly asking "Why?" and it is a simple and efficient problem-solving technique (Dziuba et al., 2014). Continuously asking "Why?" reveals hidden layers of problems, exposing underlying root causes that may not be readily evident (Gangidi, 2017). The Pareto charts hold the 80-20 rule, highlighting that 80% of the impact is generated by 20% of potential causes, therefore prioritizing these "vital few" factors can result in substantial improvements (Benjamin et al., 2018). The Ishikawa diagram, also known as the fishbone diagram, originated in the Japanese industry and has since become a globally recognized tool for quality control and improvement. The Ishikawa diagram comprises six main branches used to explore causes related to a specific event. These six categories are Man, Machines, Materials, Measurements, Methods, and Environment (Kenett, 2008). A root cause is the most fundamental root cause or root causes of a positive or negative problem characteristic of any process, which, if addressed, will eliminate, or significantly reduce the problem characteristic (Preuss, 2003). This indicates that the roots need to be dug deep to uncover the majority of them.

Although some studies reported above production planning, production planning tools, and process improvements, a significant research gap becomes apparent, as there is a notable scarcity of studies focusing on the apparel accessories industry in Sri Lanka with regard to production planning improvements aimed at ultimately enhancing OTD performance.

3. Methodology

3.1. Data sources

To achieve the objectives, the study selected the exploratory research design since it helped to clarify and analyze the research problem further while discovering new insights. Most of the data and information in the problem were gathered from the experience of the people who engage in real with the process. Therefore, in this study, the main research approach was qualitative research since it mainly considered the subjective experience of people (Leavy, 2017). Qualitative approaches explore the situation, experience, and perception. It is built upon observational data (Kumar, 2011). For the data collection phase, the study selected Unstructured and Semi-structured Interviews, Focus Groups, and Unstructured Observations employed as primary data collection methods, and company records employed as secondary data collection methods which comes under the qualitative research approach (Arendt et al., 2012).

3.2. Data analysis

Figure 1 shows the research process of the study. After observations, focus group discussions, and interviews the researcher mapped the AS-IS process and got a broad idea about the current production planning process of RFID. Based on the data gathered the researcher conducted a Pareto Analysis to identify the most significant reason and based on that cause-and-effect diagram was plotted. To validate the all-possible reasons identified in the cause-and-effect diagram the study conducted brainstorming sessions. Then using 5-why analysis the study identified the root cause. In the final phase researchers built a model of a production planning tool with other related process improvements.

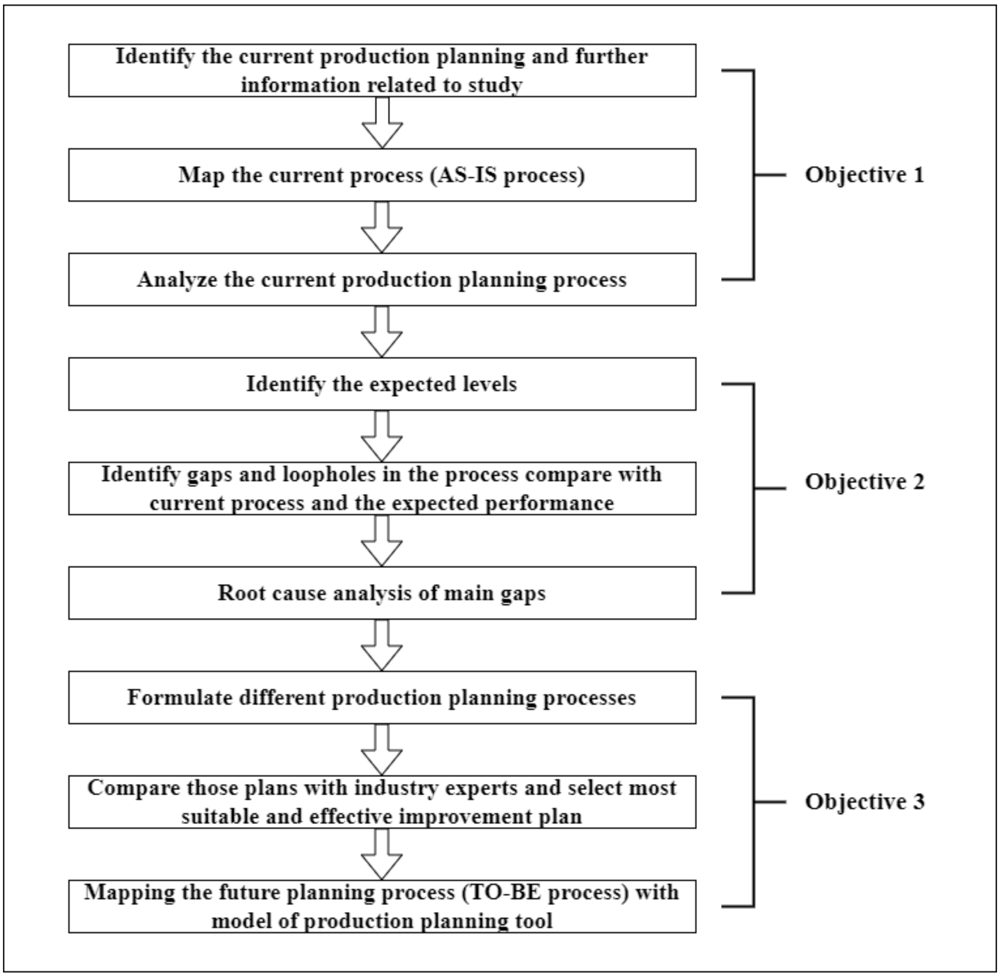

Figure 1. Research process.

4. Results and Discussion

The first objective was to understand and map the current production planning process and Figure 2 shows the partial view of the AS-IS Map.

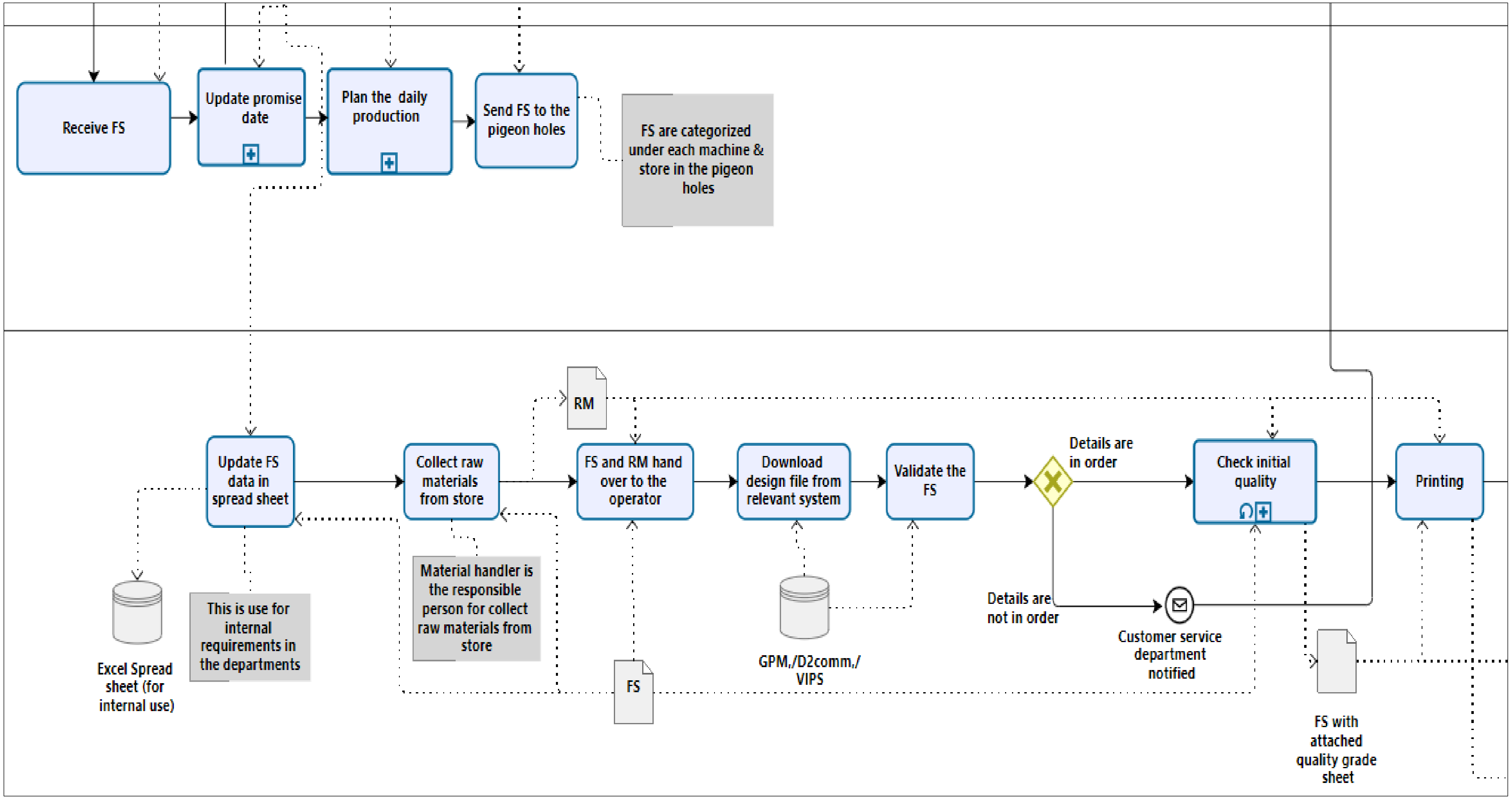

Figure 2. AS-IS process map (partial view).

In order to study the current production process researchers conducted interviews, focus group discussions with stakeholders, observations, and accessed some reports and documents. The AS-IS process map of the RFID department was created using the standard BPMN 2.0 process mapping technique. Upon receiving orders, the Customer Service Department creates a detailed Factory Sheet (FS) with order, customer, and product information. This FS is then passed to the FS distributor who enters FS data into the system and forwards it to the Raw Material (RM) allocator. The RM allocator checks material availability, updates the FS accordingly, and collaborates with the supply chain if materials are needed. Upon receiving the FS, the production planner updates the promise date in the system. Daily planning involves rearranging FSs according to the promised date, entering FS data into Google Sheets, and scheduling production according to worker availability. The material handler provides necessary RMs to machine operators alongside the FS. Machine operators verify the FS against the customer's original order, initiate the production, and obtain quality approval for a sample before bulk production. Upon production completion, check quality requirements and send finished goods to the dispatch unit.

The second objective was to identify the root causes for the gaps between expected and current performance. According to the AS-IS map, it showed that after an order was received, the planner gave a promised date by adding a 5-day lead time. The researcher analyzed the data related to order input dates and promise dates that were given to customers which were gathered from the Industrial Engineering (IE) department using hypothesis testing to check whether the orders were completed within a 5-day lead time ($H_0: \mu \leq 5$ vs. $H_1: \mu > 5$).

Table 1. Hypothesis testing results.

Mean	35.11723
Standard deviation	16.17151
Count	981
Level of significance	0.05
t-stat	58.1
p-value	.000

Table 1 describes the significant value as .000 which means $p < 0.05$. Therefore, the researcher can conclude that 95% of the orders are not completed within 5 days of lead time.

Based on these results and brainstorming sessions with the production planner and production manager regarding the production planning, the researcher identified that there was a problem with giving accurate promise dates to the customer since fewer factors were considered by the production planner. The lead time of 5 days was merely taken into account; however, material, machine, and man availability were not accurately checked due to the unavailability of the proper system. The less accurate promise date directly affects the proper production planning and through that OTD rates will be affected. Since the research mainly focuses on the flexibility of the production, which is measured by the OTD rate, the research further analyzes the reasons for OTD using some numerical data which were gathered from the IE department and plotted a Pareto Chart as shown in Figure 3.

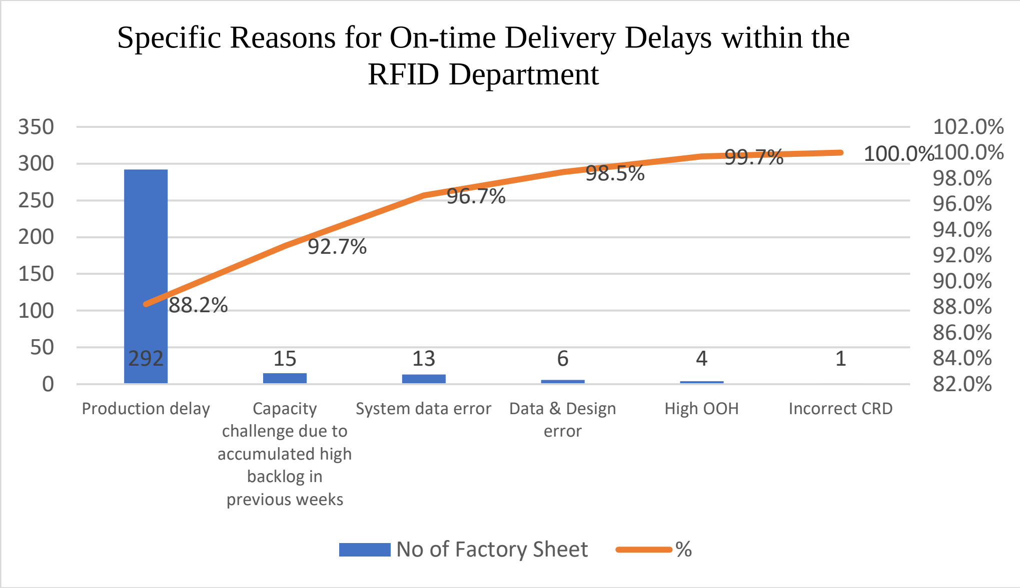

Figure 3. Pareto analysis.

Based on the data, it appears that more than 80% of OTD delays are due to production delays in RFID. Since production delay is a vast area, it may occur due to various factors. The research used a cause-and-effect diagram to analyze it further to identify all possible reasons using a few brainstorming sessions.

The research conducted a few focus group discussions with the production manager, planner, and operators to check the validity of the causes identified in the cause-and-effect diagram as shown in Figure 4**.** Finally, from the cause-and-effect diagram following causes were found as the most validated ones; Inefficient tracking of employee availability and skills, Inefficient production planning technique due to lack of visibility of data for considering factors such as availability of material, machine, and operators, and lack of real time production monitoring since no real time data capturing tool. When evaluating the above causes researchers classified them into two main problems.

1. Less visibility in the data (i.e., material, machine, and operator availability)
2. Employee availability

According to Figure 5, the researcher conducted a 5-why analysis with the production planner to analyze the problem of less visibility in the data and identified that the lack of necessary production planning tools is the root cause. The analysis was conducted using the following phrases; Why is there less visibility in data? Why essential data for production planning is unavailable? Why is data stored in disconnected databases? Why do departments utilize separate databases? Why there is a lack of a centralized system?

When it comes to employee availability problems the planner must verify the machine operators' availability for each machine after getting the factory sheet. The following day the availability of the machine operators must be checked by the planner. Therefore, operators should be informed about their availability for the following day during each day. To monitor the availability of the operators, they maintain an updated Excel file with this information. By assigning each machine operator to the appropriate machine using

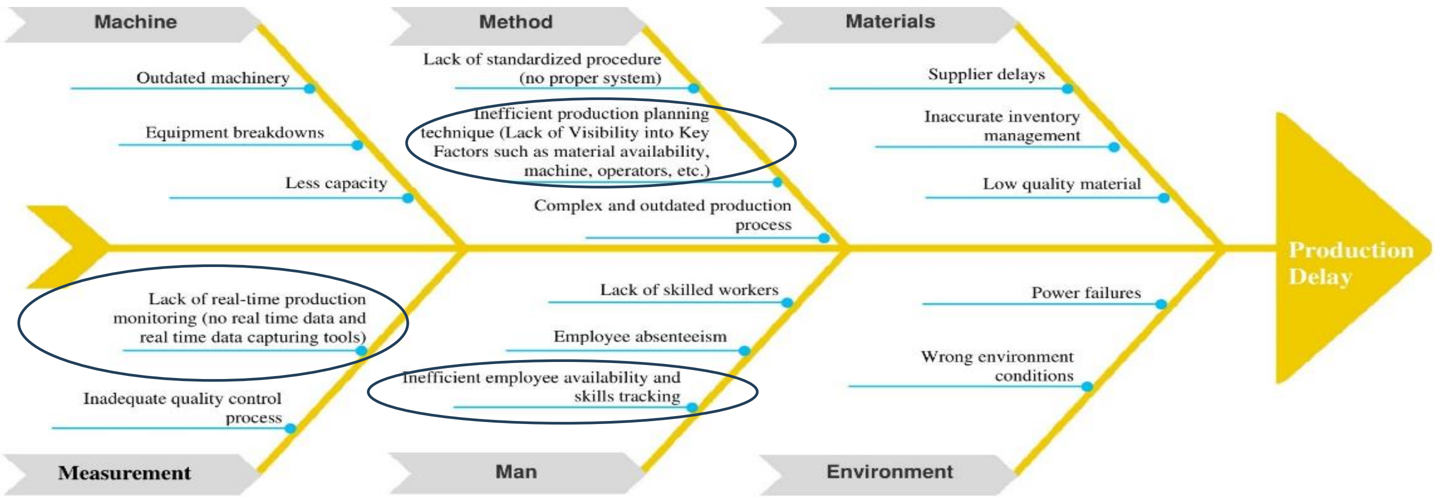

Figure 4. Cause-and-effect-diagram.

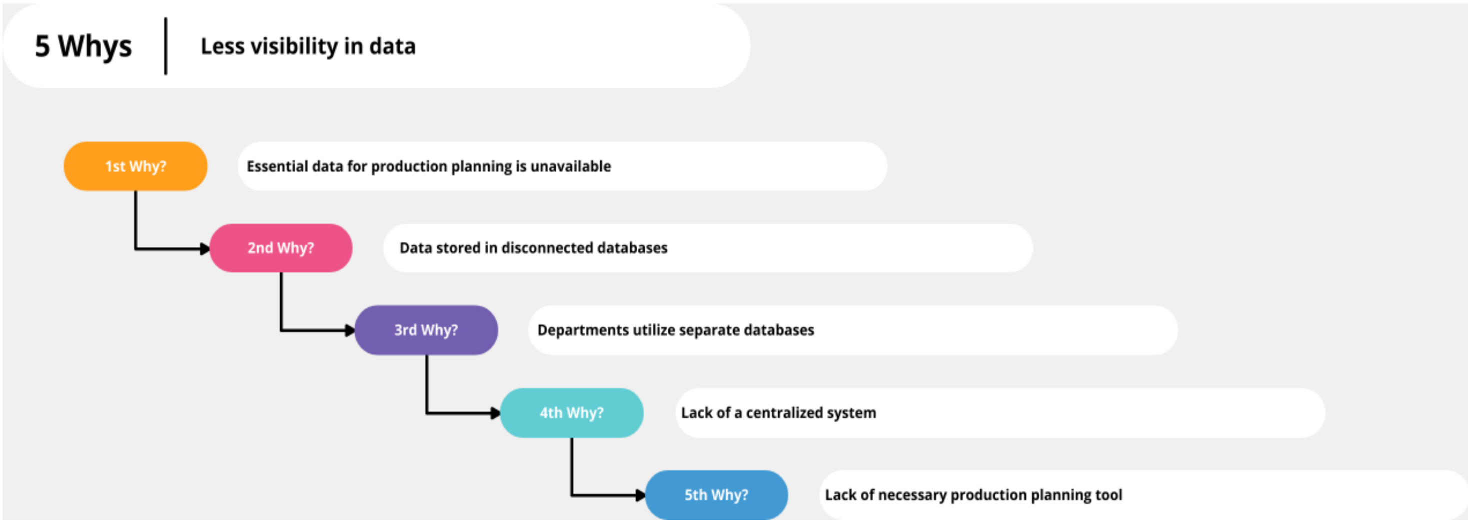

Figure 5. 5-Why diagram.

that information, the planner arranges the production for the following day. The plan, though, may change if the operators are absent unexpectedly. In this situation, the planner must alter their initial plan. Since this process is managed by a single person, it will be challenging for RFID if the planner is also unavailable on that day.

The third objective of the study was to Suggest improvements to achieve the expected performance in the form of a model of a production planning tool with related process improvements.

4.1. Production planning tool

Having understood the major challenges and their root causes, when developing the production planning tool, it aims to enhance the visibility of the data mainly material and machine. The researcher utilizes fabricated data for a basic illustration. First, as shown in Table 2, this planning tool requires details about the types of materials required for each product, the quantities of raw materials required for one unit of each product, and the types of machines assigned to each product.

Table 2. BOM details and assigned machines.

Products	Material										Machine	
	1	1Qty	2	2Qty	3	3Qty	4	4Qty	5	5Qty	1	2
P1	R2	0.003	R3	0.003	R4	0.003	R5	1			M1	
P2	R1	0.005	R2	0.002	R3	0.002	R6	1			M2	
P3	R3	0.003	R4	0.003	R5	1					M1	M2

The recommended planning tool considers the current inventory of each raw material, its unit of measurement, and raw material receiving dates to check the material's availability. To get the material data, RFID needs to link with the stores' department, and they already maintain a database using these data. In order to check the machine availability, this planning tool considers the capacity of each machine by considering whether the machine is currently in use or not, and when the machine will be available if it is currently in use.

When the RFID production line receives an order, the planner can enter the order details into the recommended production planning tool, such as the order received date, factory sheet number, product type, and order quantity. Then, the recommended production planning tool automatically calculates the promise date of the order based on machine availability, material availability, and lead time according to Figure 6. If the machines and materials are currently available to begin production, this tool provides a promised date by adding five days (lead time) to the order received date. However, if the machines or materials are not currently available, this tool provides a promise date by adding five days to the machine or material availability dates.

Using the planning tool, the RFID department can easily get the most accurate promise dates than previous, and this ensures the resulting accurate production plan. However, this tool does not completely solve the problems related to production planning but makes production planning easier and more accurate than the current planning. They can further improve this tool to convert promise dates into a calendar view with the customer reference number and give access to the customer service department as well. From that,

Date	Factory Sheet Number	Product	Quantity	Machine Avaibale Date	Materil Avaliability	Material Available Date	Promise Date
14-Sep	1	P1	20000	1-Oct	No	12-Oct	17-Oct
22-Sep	2	P2	1000	27-Sep	Yes	22-Sep	2-Oct
30-Sep	3	P1	10000	1-Oct	No	20-Oct	25-Oct
05-Oct	4	P4	25000	5-Oct	Yes	5-Oct	10-Oct
07-Oct	5	P3	3000	7-Oct	Yes	7-Oct	12-Oct

Lead Time (days)
5

**Material Availability				
1	2	3	4	5
12-Oct	14-Sep	14-Sep	14-Sep	14-Sep
22-Sep	22-Sep	22-Sep	22-Sep	22-Sep
20-Oct	30-Sep	30-Sep	30-Sep	30-Sep
5-Oct	5-Oct	5-Oct	5-Oct	5-Oct
7-Oct	7-Oct	7-Oct	7-Oct	7-Oct

Figure 6. Interface of the production planning tool.

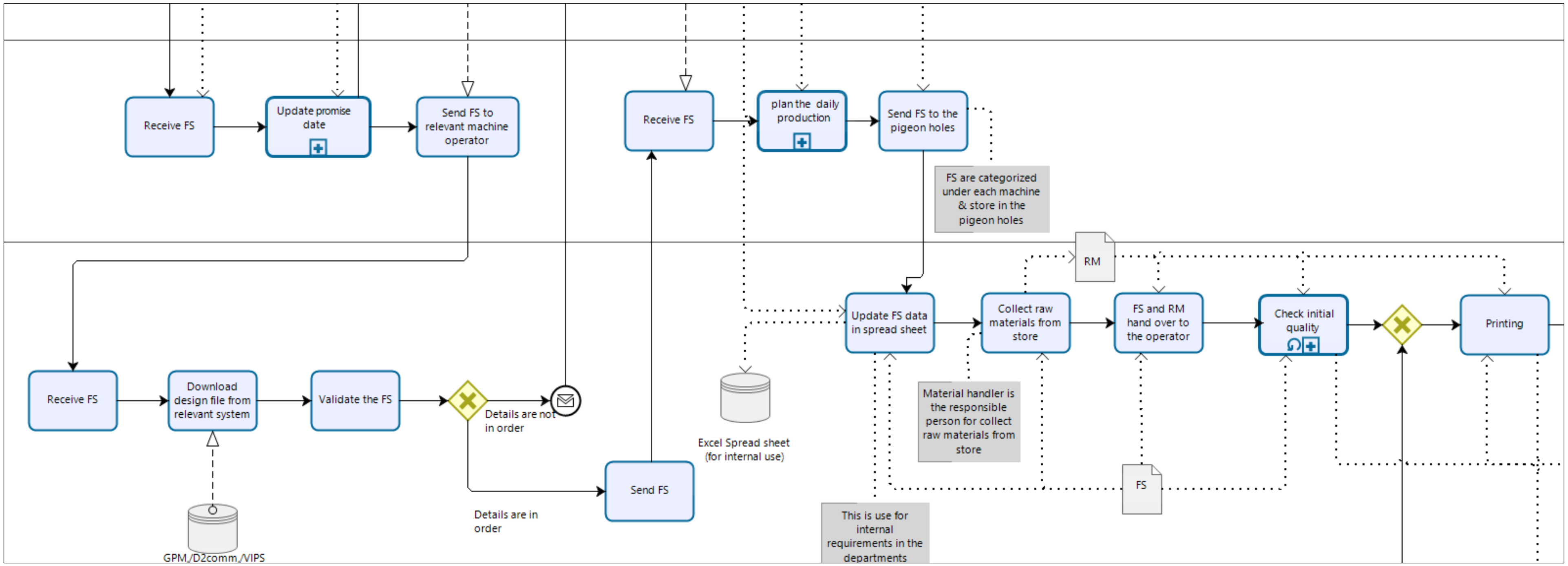

Figure 7. TO-BE process map, after implementing production planning tool with other process improvements (partial view).

they can get an idea about promised dates when getting urgent orders. The tool was created using MS basic Excel functions, and it can be further improved by using Macro-Excel functions. This research recommends implementing an ERP system, especially for production planning. This would improve information flow, reduce errors, and enable data-driven decision-making through reports and dashboards.

4.2. Maintain an employee skill ranking list

To address the issue of no mechanism for dealing with sudden absenteeism which is identified when achieving the second objective the researcher suggests a skill ranking list. The current skill matrix of the RFID department evaluates employee skills per machine but lacks a mechanism to identify the best replacement in case of operator absence. To address this, the recommendation is to create a skill ranking database for each machine. This would simplify the process of selecting the next best operator for a particular machine during unexpected absences. After creating the employee ranking database, their current process can be improved. Alpha Lanka (Pvt) Ltd should visualize the skill matrix for operators to track their skills, motivate improvement, help to identify skilled employees, and plan targeted training programs.

5. Conclusion and Implications

This study aims to enhance their RFID production line's OTD, vital for flexibility KPI improvement. The study achieved research objectives 1 and 2 by mapping the current process, identifying issues, determining root causes, and using numerical data to identify specific OTD delay reasons. Finally, the research achieved objective 3 by recommending a production planning tool as the primary solution for these issues along with other process improvements and mapped the TO-BE process. To significantly improve OTD, these recommendations should be implemented within the RFID, which will take the company's production operations to the next level, which means developing a planning tool that enables simultaneous planning and scheduling to enhance the company's operational efficiency, which will maximize the overall workload and reduce production time and costs, enhance customer satisfaction, and indirectly impacting the garment and textile industry and the Sri Lankan economy. Future recommendations have been identified based on the entire study. RFID department needs to sharpen its processes and focus on process-driven procedures rather than people-driven. The recommended upgrades and a planning tool for RFID production need careful change management due to operational adjustments and potential resistance. Alpha Lanka (Pvt) Ltd has rigid IT policies, like favoring Excel Sheets over new software, emphasizing the need for more flexible IT strategies.

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