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Dietsche, Heather E. ***Impacts of Digital Enablement on Daily Management in Manufacturing***

Abstract

Company XYZ faced challenges with making their daily management system effective. To enhance the effectiveness of the daily management system, digital business intelligence dashboards and digital accountability boards were implemented. These digital solutions were displayed on TVs near two different production lines where morning meetings are held for each value stream respectively. The intended outcome for this system is to identify gaps to intended production outcomes, identify causes of the gaps, and increase follow-through on resolving those causes. Overall, the new system had a positive impact on pre-determined metrics. Of the metrics that were not affected by the intervention, they were not negatively impacted. The survey completed by stakeholders involved with the value streams studied indicated that they believed incorporating digital dashboards into the tiered daily management system is the right approach. These results are encouraging for the current system but are also challenged by the confidence level in the data provided. Stakeholders are still cautious of trusting the data provided, which can obstruct the teams from making decisions or making the correct decisions for production. It is recommended that Company XYZ improves data integrity as data availability increases. The findings support the expanded use of the digital dashboards to other areas in the plant.

Acknowledgments

I would like to take this opportunity to thank those who have encouraged and mentored me throughout my collegiate career up to this point. First, I want to thank my husband, Aaron, who has always seen my potential and supports my efforts in realizing that potential. I'd also like to thank my son, Ariston, who has sacrificed a lot of quality time with me while I completed both my bachelor's and master's degrees. This accomplishment could not have been possible without the support from other family members who assisted with childcare and other logistical support. Specifically, my mother and father-in-law, Mark and Lynn, have been unwaveringly supportive throughout this journey.

Professional, I have been fortunate to have tremendous mentors and managers who have impacted my educational journey. My first manager in the industry, Pete Koenig, gave me foundational knowledge in lean manufacturing and gave me my first opportunity to work in a manufacturing environment. He led by example and always made the production team members feel valued and heard. Bailey Harder has also been supportive in my endeavors and has been a mentor throughout this study. Both of these leaders are great examples of how to be supportive professionally and how to focus on outcomes that are in the best interests of all involved whenever possible. Thank you to my adviser, Eli Aba, for guiding me through this process.

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Chapter I: Introduction

The industry of medical device manufacturing is ever changing and requires an agile approach to value stream management. Original manufactureres rely on contract manufactures, like company XYZ, to ensure their new products are streamlined to high volume production and maintained throughout the lifecycle of the product. Once the product is in the hands of company XYZ, the original manufacturer is trusting that the company will uphold the quality of their product per ISO 13485 standards in addition to minimizing the resources required to do so. In order to meet the demands of their customers, Company XYZ is made up of several cross-functional departments. These departments include production, quality, maintenance, tooling, manufacturing engineering, process engineering, planners, and warehouse staff. Thse groups are spread out across multiple shifts and are relied upon for exceeding the expectations of over 25 customer at the facility in question with medium to high volume product lines. These cross function groups are expected to come together to produce the desired outcome for these customers and minimize the resources to do so.

In an effort to streamline the communication process, the operational excellence team at Company XYZ has promoted an initiative to adopt a tiered daily management system (Mann, 2015). This system includes at minimum 2 daily meetings. The Tier 1 meeting is meant for the production staff to share information to the oncoming shift during shift change. The Tier 2 meeting is intended for communication from production to the other cross functional teams. An additional tier (Tier 3) is held on weekdays with the management team to discuss any issues that could not be resolved during Tier 1 and Tier 2. The purpose of this structure is to ensure that the production staff has an opportunity to share and escalate busienss needs when appropriate. If an issue cannot be solved at Tier 1, it is then raised to the Tier 2 meeting, and so on.

The team at the facility is familiar with the tiered daily managemen structure. However, there has been a continuous resistance to embracing this initiative. The first roadblock has been the lack of access to data. A requirement of a tiered meeting is to have agreed upon key performance indicators (KPI's) to measure the success of the last 24 hours and to point the team in the direction of issues to address. However, this requires the team to manually retrieve data form the enteprise resource planning (ERP) system and manufacturing execution system (MES). By doing so, the supervisor would be taken away from critical tasks within the first hour of their shift. The next roadblock to assess is the attendees of the meetings. While it would be optimal to include a key player from each cross functional team in the Tier 2 meeting, that becomes difficult when these individuals start at different times of the day. In addition, the value stream would benefit by having the operators at Tier 1, but we also need the operators ready to take the production buton from the last shift to avoid any downtime on the production line . Arguably, the largest roadblock is simply a lack of communication between the shifts. There have been many instances where the team is trying to gather information in a Tier 2 meeting, but the current shift can't speak to issues that occurred on off shifts. In an attemp to overcome these roadblocks, Company XYZ shifted it's focus to digital enablement.

When initiating the discussion regarding marrying digital enablement and tiered daily management, we outlined our needs and what path we could take to get there. We asked ourselves "how can we automate data collection and visualization," "how can we allow that data to be seen and analyzed from any location we need to be at," and "how can we increase communication between shifts?" When looking towards solutions, the team reverted back to digital enablement. By creating digital tools, we can see data in real time, we can take that data anywhere it's needed in the plant, and we can provide a platform for each shift to share

production delays in an organized platform. In order to refine the company's lean manufacturing capabilities with a tiered daily management approach, the company must embrace the use of digital solutioms with a humanistic approach to ensure support from all cross-functional teams.

Statement of the Problem

Digital enablement has become a buzz word within many industries worldwide. More specifically, digital enablement has promised to bring benefits such as machine learning and predictive maintenance to the manufacturing industry. Company XYZ has been slow to fully commit to digital enablement and has not been able to experience any potential benefit from being enabled digitally as a result. The company has also desired to provide more structure to its daily management structure for the past two years but has not reached its desired state. As a result, the facility is experiencing missed communication, increased costs, and delays in production. The time prior to the digital solutions being in place is a reference for the state of production before digital enablement is incorporated into the daily management structure. The effects of digital enablement on production outcomes were measured for an equal amount of time after the tools were implemented to determine the effects of the digital enablement on the daily management system.

Questions of the Study

The questions of this study were focused on the success or failure of human collaboration with digital solutions made available at Company XYZ. This study examined the following questions:

1. Does real-time data made available via digital dashboards influence the outcome of production?

2. If digital dashboards influence the outcome of production, do they create a positive or negative effect?
3. Is the tiered daily management structure enhanced by digital dashboards?
4. Does the human collaboration with the provided digital solutions improve overall equipment effectiveness?

Purpose of the Study

This study serves several purposes. The initial motivation for this intervention was to meet and exceed customer demand by providing the desired output in addition to maintaining or exceeding current quality standards. The next motivation was to reduce or minimize waste in the production process. This reduction in waste was in relation to labor, equipment utilization, and excess scrap. Lastly, this study served as a blueprint for the daily management process for other value streams in the facility. The desired outcome was a lean production system that could be expanded over time, and this study allows the company to review and confirm or reject the proposed solutions to ensure desired outcomes are achieved.

Assumptions of the Study

Regarding this study, the following assumptions exist:

1. Equipment and labor are under-utilized. This means that there is room for improvement in the use of these resources and that there is waste present in the current process.
2. The value streams referenced are focused on one product line each. This means that the digital solutions developed apply specifically to the product line being studied.

Definition of Terms

The following terms were used to provide context for the daily management process.

Enterprise Resource Planning

Enterprise resource planning (ERP) Software allows cross functional teams (production, planning, warehouse management, engineering, and maintenance) to access and organize information about the products and services they produce and/or provide (Nicholas and Steyn, 2021).

Gemba

The act of going to where the work is done and interacting with the people doing the work (Imai, 2012).

Kaizen

The process of continuous improvement (Imai, 2012).

Tiered Daily Management

A system of visual controls and standard processes that allow for the sustaining and improvement of production processes (Mann, 2015).

Visual Controls

A tool utilized to display the difference between the desired outcome and the actual outcome (Mann, 2015).

Limitations of the Study

The recognized limitations of this research are outlined below:

1. Time constraints limit a full analysis of the effects of collaboration between employees and digital tools. Due to the time available for this study, time between measurements may not have allowed for the full effects of the updated process to be realized.

2. The value streams that were assessed are focused on one product line. However, we do not have comparable lines to use as control groups. As a result, environmental changes that affect each production line cannot be taken into consideration.
3. The availability of data was a challenge in this system due to the security constraints in Company XYZ. While we had some data available through the ERP software, it was not to the extent that would be desired. As a result, manual data entry systems were created to acquire the desired data. We know that there is an expected degree of error in manual data entry, so that is a limitation of this analysis.
4. The data that could be retrieved from the ERP software was retrieved at a lag. This means that the data did not reflect production in real-time.

Methodology

To assess the outcomes from the collaboration between employees and digital solutions, the participatory action research methodology was utilized. This was done to allow for the use of Look-Think-Act approach (Omrod, 2023.) Specifically, the data was presented to the production team to “look” at or analyze during the morning meetings. I was available to provide coaching in the morning meetings to encourage the team to perform root cause analysis in conjunction with the presented data. Goals were pre-determined by the production manager, and if those goals were not achieved, the production team was expected to find the root cause as to why there was a gap between the actual results and the goal, which is commonly referred to as gap-to-goal. Last, the team was expected to assign an action item to the appropriate party to address the gap in question. This required follow-up to ensure accountability. While the production team was doing the actual analysis, the analysis is guided by me, the researcher.

Before and after the execution of the action research, predetermined indicators were assessed to determine the success of the approach. The indicators used in daily management fell under the categories of safety, quality, delivery, and cost. There were additional assessments given to the stakeholders to determine their interpretation of the success or failure of the digital solutions integrated into daily management.

Chapter II: Literature Review

To understand how digital tools can be incorporated into the employee experience, we can explore the daily management practices already established within the manufacturing industry. The purpose of digital enablement is not to have the latest and greatest technology, but to enhance the capabilities of our company for our internal and external customers' benefits. If a digital tool does not have a safety, quality, delivery, or cost benefit, it does not serve purpose in the organization.

The Fourth Industrial Revolution

There have been four well known Industrial Revolutions in the last 200 years (Nuvolari, 2019). The First Industrial Revolution was when the world started to use steam powered engines at a large scale. In manufacturing, this allowed powerful machines to get work done in the late 18th century and early 19th century (Nuvolari, 2019). Following this, the Second Industrial Revolution expanded the use of machines by incorporating the use of gas-powered engines. What is considered the Third Industrial Revolution began in the late 1970's when companies began to use automation to remove some of the human work necessary inside their factories. These transformations in industry have led to the Fourth Industrial Revolution. This revolution is based on technology integrated systems (Tortorella et. al., 2020). This revolution is most commonly known as Industry 4.0 (I4.0). While this revolution started in the early 2000's, most companies are still in the process of transforming to the age of the computer. Some would consider the fact that most of us interact with a computer every day at work and that we rely on software, like ERP systems, to process daily transactions means that this transformation has been achieved within that company. However, it is difficult to measure if a company is fully embracing I4.0 because the benchmark is constantly moving with advancements in technology.

Some main components of I4.0 include “enhanced information sharing and decision-making process, improved integration, collaboration and resource productivity, and increased ability to meet individual customer demands” (Tortorella et. al., 2020). While the goalpost is moving, considering I4.0’s effects on a value stream is integral to a company’s success in achieving the transformation.

Value Streams

To understand what digital enablement can be applied to, one must understand the concept of a value stream. A value stream involves all resources, including labor, space, materials, machine hours, logistics, and any other input required to create the end product (Rother & Shook, 2018). This could be a product line or a customer in general. Some processes may overlap with other processes used facility-wide, but it is useful to focus on a value stream as a system within itself. There are many components to a value stream. This is why it usually falls on management to map the high-level flow of the value stream (Rother & Shook, 2018). This usually leads to daily management being divided depending on the value stream in question.

Tiered Daily Management

A challenge that most industries face in their day-to-day operations is accountability and communication. To provide a platform to share information cross-functionally and across multiply shifts, a tool called tiered daily management is utilized at lean organizations (Mann, 2015). This system consists of collecting information/data, presenting that data, and facilitating a discussion around the data. More specifically, there are three tiers of daily meetings that focus on the last 24 hours of production. The intended attendees and sequence of those meetings are shown in Table 1. Please note that the attendees are based on the required attendees from Company XYZ.

Table 1

Tiered Daily Management Organization

Tier	Tier 1	Tier 2	Tier 3
Time	Shift-Change	Beginning of day shift (i.e., 8am)	Following tier 2
Attendees	Operators, finishing technicians, production support specialists, and production supervisor	Production supervisor, quality technician, mold technician, engineers, production manager	Production manager, cross-functional managers, plant manager
Topic	Last 24 hours of production. Tier 1 KPI's	Last 24 hours of production. Tier 2 key process indicators (KPI). Items escalated from tier 1.	Last 24 hours of production. Tier 3 key process indicators (KPI). Items escalated from tier 2.

Note. From *Creating a Lean Culture,* by D. Mann, 2015, p. 119. Copyright 2015 by CRC Press.

Visual Controls

The use of visual controls is an industry standard to highlight a team's gap-to-goal. That means "to compare expected versus actual performance" (Mann, 2015, p. 77). Visual controls should be easy to reference with the use of colors, shapes, and layout to show the gap or achievement at a glance. A visual control example is an hour-by-hour production tracking chart. This chart can be utilized to track the actual output versus the expected output. In addition, it should provide a reason for not reaching the expected output. Another example of visual control is an accountability board. This type of board can be used in tandem with the tiered daily management to assign action items to cross-functional teams (Mann, 2015). The example provided looks similar to Table 2.

Table 2

Accountability Board

Date	1/1	1/2	1/3	1/4	1/5	1/6	1/7
Team member 1	Task 1						
Team member 2			Task 2				
Team member 3							Task 3

Note. From *Creating a Lean Culture*, by D. Mann, 2015, p. 117. Copyright 2015 by CRC Press.

Automation

There is hesitation to automate visual controls and data acquisition in lean manufacturing. Mann (2015) cautions against the use of automated tracking. He notes that access limitations, network issues, and transmission errors can cause unreliable data (Mann, 2015). As we continue the path to digital enablement in manufacturing, these are obstacles that must be considered. If there is distrust in the data, there will be minimal actionable items assigned to overcome production gaps. He also notes that reason codes for downtime lead to vague descriptions and limits process improvements (Mann, 2015). This is a re-occurring issue at Company XYZ due to the variety of assembly lines requiring customized downtime reasons. This resistance to digital enablement is justified and important to consider as the company proceeds down this journey.

Continuous Improvement

Continuous Improvement can take on many forms within a company. It can span from a 15-minute effort to a week or months long event. Kaizen and Gemba are two concepts that assist in continuous improvement activities within a company.

Kaizen

Kaizen is a Japanese term that means continuous improvement (Imai, 2012). It is important to remember that this term is not an event or a task, but a way of managing production daily. That means that while there is a desired result, the process used to achieve the result is referred to as a kaizen process. More specifically, most refer to the Plan-Do-Check-Act cycle (Imai, 2012). The basis for this cycle is that it may take several iterations of this process to achieve the desired outcome. This process allows for new ideas to be tried, tested, and reformed several times before the kaizen process is complete.

This process is utilized at Company XYZ but is referred to as the Idea Generation Process. As outlined by Imai, ideas are submitted by employees on cards. Those cards are assessed weekly and assigned to people who can facilitate executing the idea. The ideas then goes through Plan-Do-Check-Act cycle. This process is built around the traditional lean manufacturing principle of the kaizen process. Most recently, this process has been updated to a digital form. Employees can scan a QR code, enter their ideas into the digital form, and then submit them. Their submissions are automatically transferred to a digital planner where they are assigned to engineers, given a due date, and comments are added. This was an integral step to introduce digital tools to the site. While it took a couple months to be fully adopted by employees, the site is receiving more ideas than ever from employees and has a sustainable process to track and complete these ideas.

Gemba

Gemba is the concept of going to where the work is done (Imai, 2012). Gemba is based on the concept that management has both internal and external customers. Cross-functional teams and supervisors are at the service of the people producing the product (Imai, 2012). To

determine what the production staff needs, the support staff must go to the production floor and ask questions. Gemba is one of the sources of kaizen (continuous improvement).

In Company XYZ, missed opportunities and poor process flows are found every time we execute a Gemba walk. This can make some managers resist the exercise. However, if those large problems are worked through and solved, the trust between management and production will grow. This will bring more ideas to light, and a collaborative environment can be achieved. Most importantly, Gemba's are an opportunity for a bottoms-up approach to improvement.

Collaborative Intelligence

Collaborative intelligence highlights the complimentary interactions between artificial intelligence (AI) and humans. It is the idea that AI and humans working together should feel like an orchestration. Three factors of this concept are that AI and humans can work collaboratively, they can have a shared objective, and their interaction is sustainable (Schleiger et al., 2024).

Successful integration between AI and humans is not the interruption or addition of the human work, but rather the AI is working with the human. This entails building AI tools that remove the work that a computer can do, allowing humans to focus on work that only humans can do.

Collaborative Channels

A collaborative channel is the tool in which AI and humans interact together. This could be a series of sensors that work together to collaborate with a human or a graphical user interface. One channel that has proven beneficial is the patient management system named SAGE (Schleiger et al., 2024). This system provides non-subjective prompts for providers to present to their patients to gather the patient's health information without any discrimination or prejudice. This is an example of a tool that is used in a setting where questions are already being

asked while enhancing the accuracy of the diagnosis of the patient. Another tool that has been used to enhance outcomes while utilizing AI is an application called HALS (Schleiger et al., 2024). HALS is an AI assistant that works with pathologists to label samples, which increased output by 94% and increased quality by 4.34% (Schleiger et al., 2024). These are both examples of getting information in an accessible location and removing work that a computer can do so that humans can focus on work that only humans can do.

Analytical Approaches

There are many approaches one can take to analyze data in a business. The approach chosen depends on the goals of the analysis. Real-time analytics and predictive analytics are two beneficial approaches. While they may overlap, there are two different approaches. Even with the right approach, one can still experience roadblocks to success. By highlighting the keys to successful digital enablement coupled with the correct analytic approach, a company can realize a true digital transformation.

Real-Time Analytics

Real-time data analytics is in reference to data that represents the current state of the process being analyzed. An example of this would be the use of RJG Inc's module, copilot, to show the live processing data for injection molding machines. Real-time data can empower employees to feel confident in their decision-making in manufacturing operations. It has been shown that "…in the presence of real-time technologies and a culture where organizational decisions are driven more by data, and individuals have the skills to interpret this data, supply chain performance can be improved" (Oliveira et al., 2023, para. 80). The study continues to highlight that increased digital tools, like dashboards, decreases the need for area managers to have advanced analytical skills. Rather, key individuals are used to develop analytical tools for

cross-functional teams. This strategy is best used in conjunction with an analytical culture. Individuals do not need to know how to make the analytical tools, but they must know how to make decisions based on the data provided from the tools developed by skilled personnel.

Predictive Analytics

There are different forms of predictive analytics. One form, recursive partitioning algorithms (RPAs), utilizes decision trees to predict the outcome of a set of parameters (Verbeke et al., 2017). Linear regression uses another form of predictive analytics (Verbeke et al., 2017). This is a multi-variant strategy to determine expected outcomes. Closely related to linear regression is neural networks, which can be used to replicate human thought in defined circumstances (Verbeke et al., 2017). This is different than a decision tree as it takes into consideration the weight of each input to create the output. These are just a few approaches to predictive analytics.

Roadblocks to Success

When going through a digital enablement transformation, companies will face many roadblocks. Top management support is reported to be one of the key factors in the success of a digital enablement program (Lai et al., 2018). A generally accepted strategy is to encourage change from the bottom up, but the infrastructure and financial inputs for digital enablement require a more structured, top management approach. Another roadblock to be overcome is financial readiness (Lai et al., 2018). A company may not be able to provide the physical resources required to implement digital enablement. This could include tablets, laptops, servers, edge devices, digital displays, and software. Some, like software, will include costs like service and licensing fees. It may not make sense to invest in digital enablement at the highest level for all companies. Additional roadblocks, like information technology (IT) support and general

confidence in the system will be the last gating factors to digital enablement (Lai et al., 2018). Even with financial investment and top management support, digital enablement cannot be achieved without the proper skills and the belief of the effectiveness of the system (Lai et al., 2018). This can sometimes go hand in hand, as most personnel that would be the consumer of the digital tools aren't the ones building it. The personnel building the digital solutions will need the buy in from the consumer of the data to achieve digital enablement. With all that said, financial readiness and top management support must be achieved before successfully hurdling the technical skills and buy-in necessary to realize digital enablement.

Keys for Success

Success of digital enablement is based on several factors. One factor is the understanding that successful digital enablement is dependent on not only IT personnel, like data solutions architects and data engineers, but also those knowledgeable in business processes (Minelli et al., 2013). This concept revolves around more than just a daily status report, but rather the interactions between data consumers and the data. What are the outcomes of providing that data? If the digital tool is presented in a manner that doesn't seamlessly intertwine with established daily norms, it may not be as accepted as anticipated. Citizen development is another factor that can contribute to the success of digital enablement at a company. It is common to see companies minimizing their available IT support. At times, there can be one in-person IT person servicing 2-3 facilities, while most of the IT support is remote. By deploying citizen developers, companies can relieve the reliance on their IT departments and put more control in the hands of the end user. Personnel actively involved with operations tend to produce better solutions to their known problems when they are provided with the ability to create their own business intelligence (BI) solutions (Minelli et al., 2013). Integration capabilities are a huge factor in the success of

digital enablement. Most companies already have established ERP systems that hold a vast amount of their operational data. These systems are the heart of their business. Therefore, feasible digital enablement tools must be integrable with the previously established systems (Minelli et al., 2013). Digital enablement may not be in reach for companies that don't recognize these factors for success.

The resources above outline how manual systems, like continuous improvement and visual controls, have the potential to be enhanced by digital enablement. The digital enablement must be approached with a collaborative ideation between the computer and the human to be successful. To achieve this success, customized digital tools solutions are encouraged to be explored.

Chapter III: Methodology

As stated, the method to execute this analysis was based around the structure of safety, quality, delivery, and cost (SQDC). This was a pre-established concept in Company XYZ, and it was expected that SQDC would guide each tiered meeting. Safety is the company's top priority and is the first topic discussed daily. Quality is the next focus for the meetings as the quality of our products can affect a patient's health and, in some ways, is related to safety. Delivery measures the success of producing products. Lastly, Cost measures show how much was invested to achieve those deliveries. These four topics guide discussions, and the decisions made daily. The researcher has completed the Social-Behavioral-Educational (SBE) Comprehensive Basic Course from the Collaborative Institutional Training Initiative (see Appendix A). In addition, this research method has been approved by the Internal Review Board (see Appendix B).

Subject Selection and Description

Participants in this research included all cross-functional teams relevant to operations. This included production, maintenance, mold technicians, quality technicians, and engineers. More specifically, the subjects for this research included the employees that attend the Tier 2 meetings for the facility's two largest value streams. This was a total of 20 participants. Utilizing a margin of error of 5% and a confidence level of 95%, 19 participants were considered part of the sample size (Raseta & Bazarova, 2019). These subjects were selected to uphold the standards of the study because they are all stakeholders within the value streams. The value streams are referred to as VS1 and VS2. The consent was obtained through completion of the Informed Consent From (see Appendix C). While verbal consent was received from the plant manager, written consent is not required as no information falling under the company's non-disclosure

agreement has been included in this research. Rather, summary statistics and customer aliases (VS1 and VS2) were used to describe the value streams and outcomes.

This study's objective was to determine how our pre-determined metrics were affected by digital solutions and collaboration with these stakeholders. These metrics were determined by the area production manager and are used in daily management of the value streams and are intended to elicit action from the participants. As a result, the study is a participatory action research study occurring through the tiered daily management structure.

Instrumentation

The instruments used to measure the success of the cross-functional teams include the KPI's that we use to measure the success of the operation (Rother, 2010). These selected KPI's aren't all encompassing. There are other KPI's that are used at a higher level to assess the business on a macro view. The KPI's in scope for this purpose is reliant on the outcomes produced by operations specifically. By that, I mean that they review data that is 24 hours or less old and drive real-time decision making on the production floor.

Specifically, a KPI we used for VS1 was Overall Equipment Effectiveness (OEE) (Saha & Chakraborty, 2016).

The OEE calculation is as follows:

$$OEE = Availability\ OEE\ X\ Performance\ OEE\ X\ Quality\ OEE$$

$$= \frac{(Total\ Planned\ Hours - Lost\ Time)}{Total\ Planned\ Hours} X \frac{Actual\ Cycle\ Time}{Target\ Cycle\ Time} x \frac{Good\ Parts}{Total\ Parts}$$

The target OEE was not the focus of this study, but there was a blanket goal of a 5% OEE improvement throughout the observation period.

Another instrument that was leveraged for determining the success of this digital enablement program was continuous improvement (CI) cards (Imai, 2012). CI cards are currently

being used at the company to collect ideas generated for improvement, which can be submitted by any employee. Over the past year, we have received several CI cards in relation to improving communication. First, the CI cards were reviewed to see if any additional CI cards regarding communication were submitted. If a card had been received, a follow up interview would have been performed to identify any gaps in communication.

As noted, the SQDC structure was used in the facilitation of data collection and analysis. SQDC is used as a guide to daily management (Mann, 2015).

Safety

Safety is our top priority. This is the first item listed in our quality policy. The KPI's in relation to safety included safety items closed, and new safety items opened in the assessment window. We also ensure safety is at the forefront of our focus through the execution of a 6S assessment, which assesses if an area follows the preset 6S standards. Those are safety, sort, set in order, shine, straighten, standardize, and sustain. Each area in the facility is assessed monthly to ensure the area meets the pre-determined standards and the resulting score is the KPI for that area. The 6S safety application built using Microsoft's Power Apps has been used to assess improvements to safety for each area in the plant since the application was deployed. The 6S results, open safety items, and 6S assessment results were the KPI's that defined the company's success in regard to safety.

Quality

Quality is another top priority for our company and our customer. One KPI the company uses for quality is our cost of poor quality (COPQ). This metric measures how much additional expense went into producing products that did not meet our pre-set standards. This includes labor, materials, inventory on hand, and machine hours. COPQ is an established report that is

used at a Tier 3 level and is built on the company's ERP system's database. While it was not utilized in daily management for the purposes of this study, we broke down this metric into KPI's that are controllable by production. The KPI used most for quality at the production level is yield. This metric is more machine or production-line specific. With this metric, we set a pre-determined yield rate for a machine or production line. If a machine did not meet that yield rate, it is considered out-of-standard. This data was retrieved from the already established data visualization software for VS1. The yield for VS2 was retrieved from a customized data entry tool built with Microsoft's Power Apps where production staff entered output and rejects. These are the two most important metrics for quality.

Delivery

Delivery is a metric that is tied to customer satisfaction. Within our facility, we consider delivery to the operating team and delivery to the customer. This means that we need to ensure that production has the materials they need to produce products for our customers and to assemble those materials when expected. Metrics that contribute to successful delivery include output and OEE. A gap between the actual output and the expected output can be positive or negative to the delivery to the customer. Inventory is also a part of delivery but is considered out of scope for this study as it is not entirely controllable by production at this facility.

Cost

Cost is generally a total valuation of the cost of goods sold (COGS). For the purposes of this research, we focused on the costs outside of our standard processes. This meant identifying ways we were below our expected COGS in addition to costs that exceeded our standard COGS. This data was retrieved from the ERP system. While actual dollar values could not be disclosed due to the non-disclosure, percentage changes are shared in this study.

To summarize, the SQDC methodology is the instrument that was used to measure the success of digital collaboration. In addition to the SQDC metrics outlined above, the success of digital collaboration was measured by using a survey. The survey was distributed to the subjects outlined in the *Subject Selection and Description* section above. The number of responders was dependent on how many replies were received. The survey was distributed at the end of the observation period to determine the perceived effects of the intervention (see Appendix D).

Data Collection Procedures

The first method of data collection involved a mixture of automated metrics and data entry provided by the cross-functional teams. The automated metrics were acquired from our ERP software database. The metrics manually provided by the teams were entered using a citizen developer tool named Power Apps (provided by Microsoft). Power Apps allows us to customize our data collection depending on the value stream it is built for. The data was streamed into a saved database. For the purposes of this project, SharePoint lists was the primary database for manually entered data. Both the automated data and manual data were displayed using either Power BI as a visual control. The data retrieved for the respective value streams are listed in Table 3 and Table 4. Please note that manually refers to manual data entry and automatically refers to data collected through the ERP system.

Table 3

VS1 Key Process Indicators

KPI	Frequency retrieved	Manually or automatically[1]	SQDC
Open safety items	One demand (as safety issues are submitted)	Manually	Safety
OEE	3 times a day	Manually (transferred from machine)	Delivery/Quality
Output per Shift	3 times a day	Manually	Delivery
Scrap cost and quantity	Daily	Automatically	Delivery/Cost

The reasons the metrics in Table 3 were chosen for VS1 are in large part due to this being an automated line with manual labor feeding material into the line. In addition to our regular ergonomic assessments during validation, safety concerns are raised through a Microsoft Form and transferred into a SharePoint list where it is updated until it is closed. OEE is the best metric for quality in this value stream because this is broken down to the Quality OEE or QOEE, which is highlighted in our daily management. OEE, output per shift, and scrap data all attribute to our delivery. Specifically, scrap can fall under both delivery and cost because each time a component is scrapped, we lose an opportunity to make a good kit. In addition, scrapped boxes add to the COGS. These are the KPI's that the production manager agreed are the most important to VS1.

Table 4

VS2 Key Process Indicators

KPI	Frequency retrieved	Manually or automatically[1]	SQDC
Open safety items	One demand (as safety issues are submitted)	Manually	Safety
Output per shift	Daily	Manually	Delivery
Quality test attempts required per device	Daily	Automatically	Delivery/Quality
Scrap quantity	Daily	Automatically	Delivery/Cost
Labor hour per device	Daily	Automatically	Cost

Again, safety is our number one priority. Therefore, we take safety suggestions from all employees as they find them through Microsoft Forms and review them in our Tier 2 meeting for VS2. Output per shift is important to the delivery category on this value stream as well. The next KPI, quality test attempts required per device, is unique to this value stream. This refers to a functional test that allows multiple attempts up to a specified maximum number of attempts. Since there are limited work centers that can perform this test, unnecessary attempts limit the number of devices that can be made. This means this KPI is applicable to quality and delivery. This test data was retrieved from the ERP system and displayed in a Power BI display. Like VS1, scrap costs are applicable to VS2. Lastly, labor hours per device is a KPI that helps us quickly assess the COGS within our control.

The survey was distributed to the participants via Microsoft Forms at the end of the observation period. The informed consent form was provided as the initial part of the survey. If the responder chose not to provide consent to be a part of the study, their response was not included in the results. The verbiage for the consent agreement is shown in Appendix A. The survey followed the informed consent agreement. Data collected from responders is identified through an ID rather than disclosing the participants' name to protect their personal identifiable information (PII) in accordance with our company's policies and procedures. Since each individual Office 365 account is a part of the company's Single-Sign-On (SSO) system, completing the form via their Office 365 account is assurance that the data collected is linked to the specified user. Our policies and procedures ensure that the SSO system meets the identification requirements for this data collection process.

Data Analysis

To measure the success or failure of the data integration in the daily management system, the current states of the value streams at the beginning of the study were used as the baseline. For both value streams, the number of safety items that were addressed in the two weeks leading to the study were reviewed. Then, the amount of safety items closed within two weeks after the intervention were compared with the safety items closed leading up to the intervention. An increase in closed safety items was considered a success. For VS1, an increase in OEE was considered a success. The percentage of the increase indicates the significance of success. Output per shift needed to increase for the intervention to be considered a success for delivery on both value streams. Again, the percentage increase in output indicates the significance of success, while the percentage decrease in output indicates the significance of failure.

The functional test for VS2 was assessed in a similar manner. An increase in yield indicates a positive impact, while a decrease in yield would be considered a negative impact. The scrap was analyzed differently for each value stream. VS1 has several subcomponents that are considered during tiered meetings. By assessing scrap quantity, we could see what areas of the machine are experiencing downtime and focus attention on those areas if the scrap quantity was high. By assessing scrap costs, we could see what areas are attributing most to COGS and prioritize action. Either way, reductions in both scrap costs and quantity were considered successful. A similar thought process applies to VS2, but the team focused on the scrap quantity only as the scrap reviewed was the full device scrap and not subcomponent scrap. Lastly, labor hours per device would have ideally decreased if this intervention was considered successful. Again, a percentage indicates the significance of the success or failure of the intervention. The

prior two weeks' production was used to create a baseline, which was compared to the results at the end of the observation period for all the above KPI's.

The survey results were summarized based on the type of question. Results were plotted with years of experience to determine if there was a correlation between the factors. In addition, results were put into a histogram categorized by department to determine if there was correlation between the department and the responses. The median values were used to analyze the scaled responses. Qualitative responses were categorized and summarized in a histogram. The categories indicate if the perception of the intervention is positive or negative to the outcome of production. The mixture of frequency distribution tables, box plots, and summary statistics encompass the assessment of the survey results.

If it was determined that the digital collaborative efforts have no effect or negative effect on the KPI's, the process was assessed and cautiously adjusted throughout the study. If it is determined that the process was improving, the digital collaborative efforts were considered a success.

Limitations

The limitations listed below were present due to the resources available leading up to and during the time of the study:

1. It takes extensive time to realize the full effects of this type of digital daily management. Thus, the outcomes may not be fully realized at the end of this study.
2. There are certain limitations that we have on data access that are set by our parent company. As a result, we may not have been able to stream all the data required to fully assess the outcomes of these efforts.

3. External factors may have impacted the measurement of success. For example, if there was an unusual quality event that occurred due to poor quality purchased components, that could have impacted the KPI's even though our internal team was not at fault.

Summary

Digital collaborative tools are ever changing in today's digital world. By pre-determining KPI's, we could assess the impact of the collaboration between digital tools and human efforts. It is important to utilize automated data to save time, but also to encourage interaction with the data utilizing manual tools. This connects participants with the outcomes they have produced and, ideally, drives improvement throughout the operation.

Chapter IV: Results

Key Process Indicators (KPI's) were successfully captured for both VS1 and VS2. The baseline KPI's were obtained during the period of April 3rd, 2025, to April 16th, 2025. This was done to ensure that the timeframe for the baseline period matched the time frame for the observation period. The observation period started at the time the intervention was implemented, which occurred on April 17th, 2025. The data continued to be captured until the end of the observation period, which was April 30th, 2025. All raw data is available in Appendix E. We must recognize the limited time frame for both the baseline and observation periods. Due to this limited time frame, these metrics are supported with the results of the Digital Enablement and Daily Manufacturing Survey. The formatting for the survey questions were altered slightly to present them in an organized manner in Microsoft Forms. The results for this survey were collected between April 28th and April 30th. This survey encompassed results from all the cross-functional teams represented at the daily Tier 2 meetings.

Demographic

The responders in this study can be categorized by years of experience within the company and by their cross-functional department within the company. The years of experience that the responders had within the company ranged from as little as three years to as many as 27 years. Of that, over half of the responders had between 4.25 and 17 years of experience, as shown in Figure 1. The cross-functional teams included in this study were quality, production, manufacturing/other engineering, warehouse, management, and team leader. The number of each team representation is shown in Figure 2. These cross-functional teams are all represented at our morning daily management meetings for both VS1 and VS2.

Figure 1

Range of Company Experience Among Responders

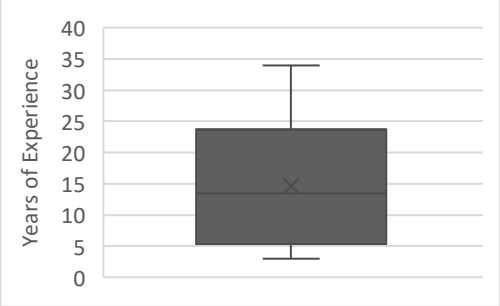
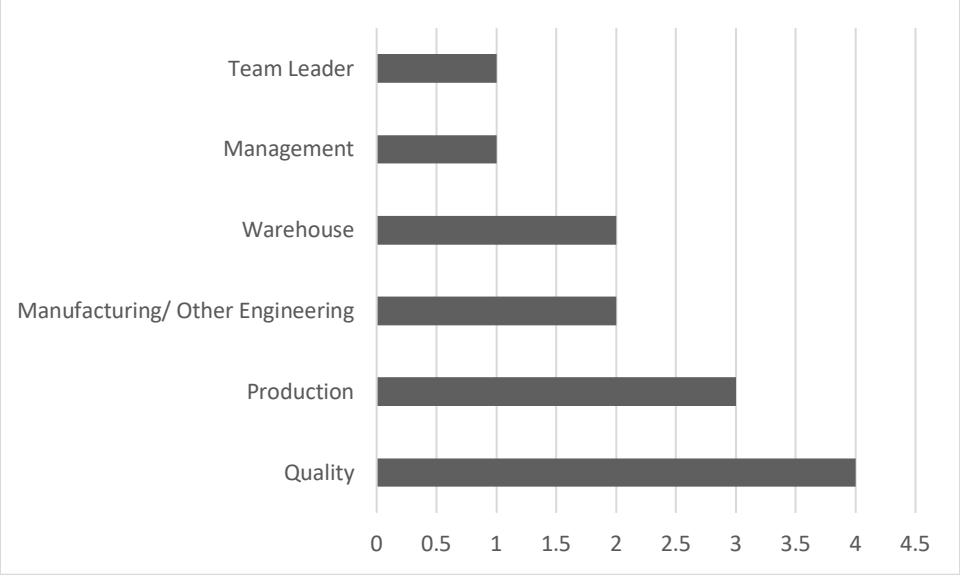


Figure 2

Cross-Functional Team Representation Among Responders



Item Analysis

Data was collected for both VS1 and VS2 prior to the intervention being applied. The intervention for that value stream had two major components. First, the Tier 2 meeting was moved from a whiteboard to a digital display. This consisted of two TVs. One showed the business intelligence dashboard made with Microsoft's Power BI with the SQDC metrics from

the previous day. The other TV was an accountability board made with Microsoft Planner. The intervention for VS2 was similar. However, business needs required that a digital dashboard be developed months before the intervention. With that in mind, the accountability board was not put in place until the time of the intervention. The strategy for both was simple. Review the key metrics, acknowledge the gaps from the goals, and assign action items in an effort to resolve any gaps currently present.

Safety

Safety was assessed on both value streams. The key metrics that indicated success or failure of the intervention in relation to safety were new safety items opened and closed safety items. VS1 had two safety items close during the baseline period and the observation period. The value stream also had 4 new items open during the baseline period and 5 new safety items open during the observation period. Neither of these metrics indicate a strong change due to the intervention. This could be because safety is a part of the company's continuous improvement efforts that occur outside of daily management. This system has been in place for over one year, and the users understand and have embraced the process. However, the production team for VS1 has benefited from the implementation of a daily ergonomic exercise that they do by following a video that has been embedded into the digital dashboard. Each shift is now participating in the exercise, which was designed to help prevent injuries specific to the movements performed by operators on this production line. VS2 had no safety items open or close during the baseline period and had one safety item open and close during the observation period. This value stream is an intricate assembly, so the safety concerns will not come to light immediately. Most of the safety concerns for that value stream are ergonomic concerns, which are being addressed via recommendations from the on-site physical therapist and the incorporation of a targeted daily

ergonomic exercise, like VS1 is doing. Both value streams openly discuss safety items encountered at the respective value streams daily, but they are not always documented in the above metrics.

Quality

VS1 and VS2 have two different metrics that represent quality. VS1 is a highly automated line. Therefore, the team relies on machine data to determine the health of the line. Unfortunately, that machine's data had to manually be transferred to a tracker. This resulted in missing data, which mainly occurred during the weekend shifts. As shown in Figure 3, the data presented shows a slight positive improvement in the quality OEE (QOEE). With that noted, Figure 4 indicates an even stronger improvement in QOEE after the intervention was implemented. It is important to note that this is a mature production line, so large changes in QOEE are not expected.

Figure 3

Pre-Intervention OEE by Date

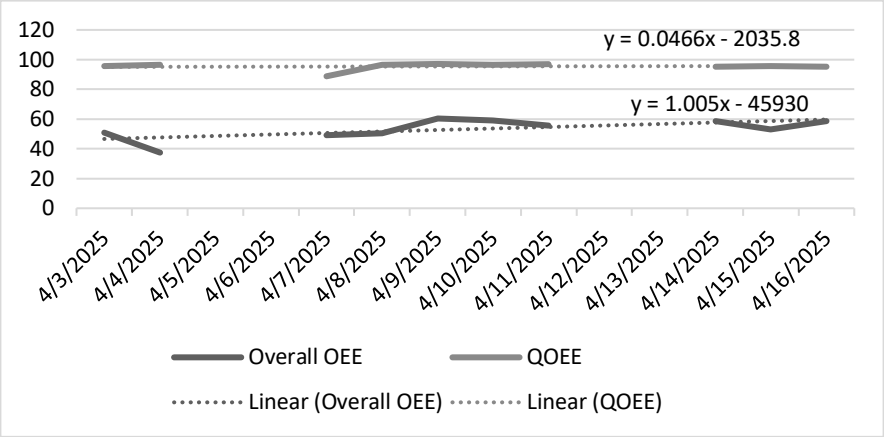
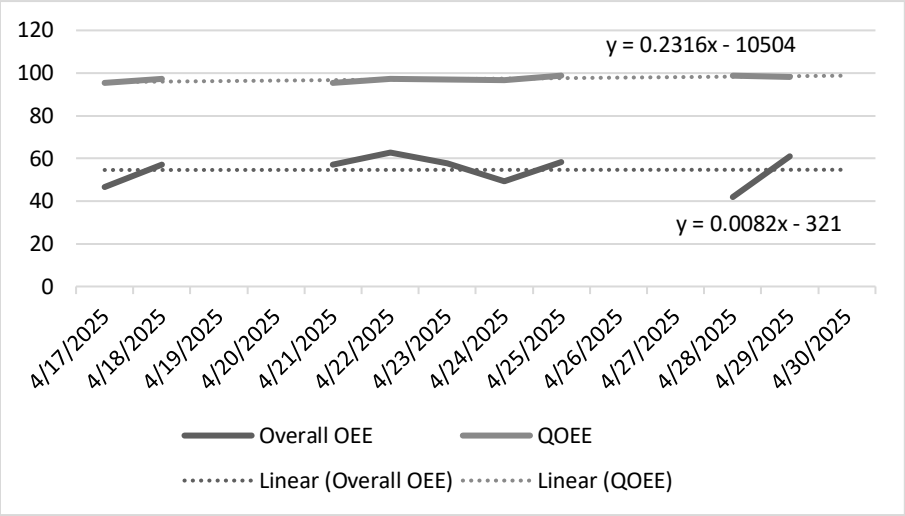


Figure 4

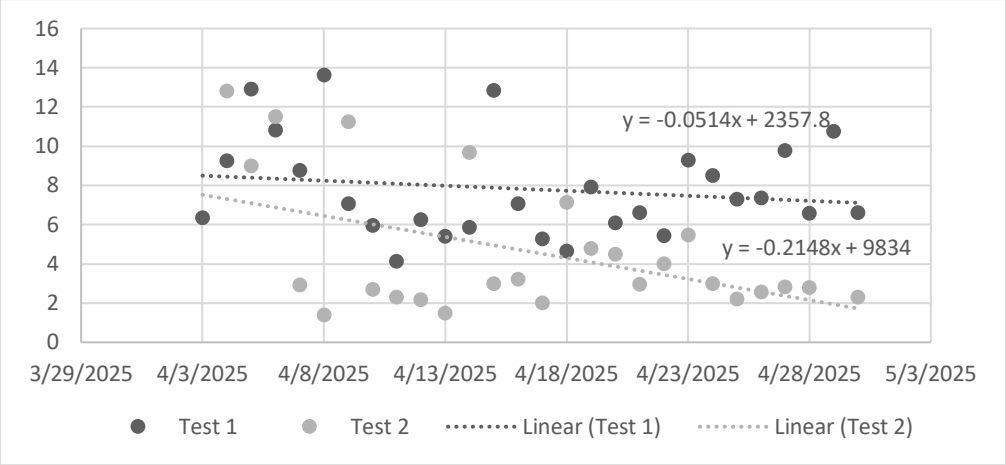
Post-Intervention OEE by Date



The quality metric for VS2 is more focused on yield from two tests, Test 1 and Test 2. During the daily Tier 2 meeting for this product line, we reviewed the test attempts per device. Each device is allowed multiple attempts of Test 1 and Test 2. Rework is done between sets of attempts. The meetings provided an opportunity for engineers to discuss the challenges the production team was facing and to share what testing they had done to find the root cause of not being able to pass the tests in less attempts. Ideally, we want to see a negative correlation between the date and number of attempts. This would mean that the number of test attempts per device is decreasing as the team progresses. Figure 5 below indicates that there is indeed a slight negative correlation between the date and test attempts per device. While this wouldn't be considered a strong correlation, this is likely due to the short duration in which data was captured. This product line is low volume, and the work orders are much longer than our other value streams, so any changes to the line will take longer to affect the outcome.

Figure 5

Test Attempts by Date



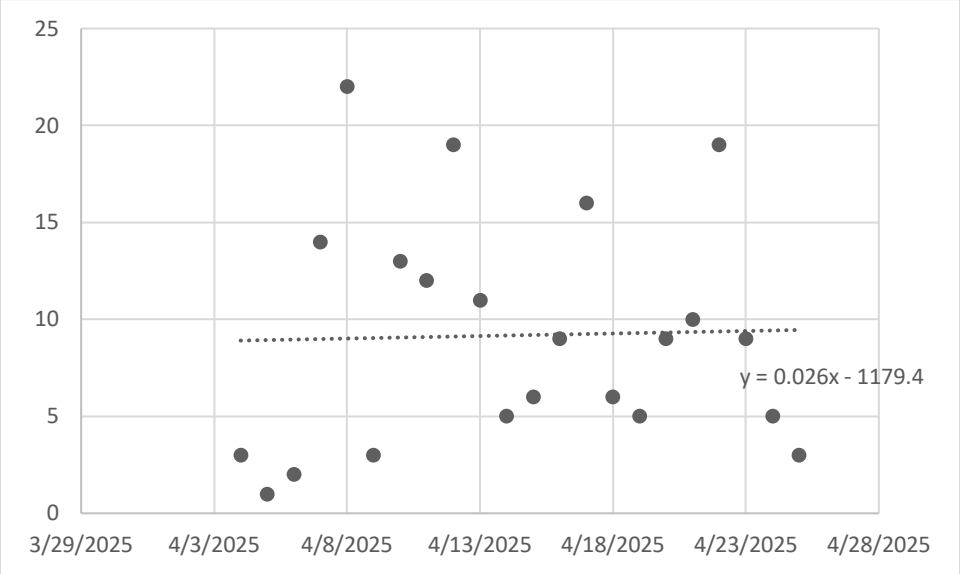
Delivery

The metric for delivery for VS1 is the Overall Equipment Effectiveness (OEE) as OEE can indicate if equipment is producing and thus delivering the demanded product to the customer (Saha & Chakraboty, 2016). Figures 3 and 4 indicate a slight positive improvement in OEE for the production line. If we look closer, we see that the rate at which the OEE is increasing pre-intervention is steeper than the rate at which the OEE is increasing post-intervention. Due to this, the data was aggregated to determine if the average OEE increased from the pre-intervention period to the post-intervention period. By doing that, it was found that the average OEE increased from 52.8% during the baseline period to 55.5% during the observation period.

VS2 is more challenging to measure an improvement in delivery as this line has recently been introduced to the production environment, which means it is still in a ramp up period to reach a stabilized output. Due to this, no baseline output has been established. In addition, this is a highly manual line, which makes it difficult to calculate OEE. For this reason, we will review the average output by date.

Figure 6

VS2 Output by Date



As shown in Figure 6, there is an insignificant change in output over time. Even when we summarize the data more by comparing the average output per day for the baseline period to the average output per day for the observation period, we see a minimal change of 9.2 devices per day to 9.1 devices per day. Therefore, there is little to no indication of the intervention influencing the output for VS2. As stated previously, this limited observation period does not allow for sufficient assessment of the daily management system's effect on this value stream.

Cost

Cost was assessed on both value streams by reviewing the percentage change in scrap costs between the baseline period and the observation period. Between the baseline period and the observation period, VS1 experienced a 26.1% decrease in scrap costs. Since this is the largest value stream in the facility, this has a large impact to the COGS. However, we cannot ignore that other factors exist in this value stream. More specifically, the line did experience quality issues on a component that began to subside between the baseline and observation period. The

reduction in the quality issue could partially be attributed to the intervention applied, but it could also be attributed to our standard quality management system as well. VS2 also experienced a significant decrease in scrap costs. The value stream experienced a 43.7% reduction in scrap between the baseline period and the observation period. It is important to note that the team is continuously conducting root cause analysis to improve the production line outcomes. These efforts are being tracked in the digital accountability tracker, which is discussed in the Tier 2 meeting daily. From my observation, when these discussions occur, the engineering team takes an opportunity to highlight their findings to the production team. This allows for immediate improvement on the production line. This collaboration is likely to have some positive effect on the scrap costs to the line based on the supporting data.

Research Questions

The questions this research was based around are focused on the perceived effects of the digital solutions integrated with daily management at Company XYZ by the stakeholders. These questions can be answered partially from the metrics obtained from the production outcomes. These results are supplemented by the survey results obtained from the stakeholders involved with the daily management of each value stream respectively, which can be seen in Table 5.

The research questions were as follows:

1. Does real-time data made available via digital dashboards influence the outcome of production?
2. If digital dashboards influence the outcome of production, do they create a positive or negative effect?
3. Is the tiered daily management structure enhanced by digital dashboards?

4. Does the human collaboration with the provided digital solutions improve overall equipment effectiveness?

A detailed assessment of the answers to the above questions will be outlined in the conclusion section.

Table 5

Impacts of Digital Enablement on Daily Management Survey Results

Question	Strongly Agree	Agree	Disagree	Strongly Disagree	Neutral	Median
Incorporating digital dashboards is the right approach to our daily management structure.	4 (30.7%)	9 (69.2%)	0 (0%)	0 (0%)	0 (0%)	4
The data presented in the morning meetings is useful.	1 (7.7%)	9 (69.2%)	2 (15.4%)	0 (0%)	1 (7.7%)	4
I feel confident in the integrity of the data presented in the meetings.	1 (7.7%)	7 (0%)	4 (30.7%)	0 (0%)	1 (7.7%)	4
Incorporating a digital task board has increased the traceability and follow through daily action items.	3 (23.1%)	6 (46.2%)	1 (7.7%)	0 (0%)	3 (23.1%)	4
The tiered daily management structure is enhanced by digital dashboards and digital task boards.	1 (7.7%)	11 (84.6%)	0 (0%)	0 (0%)	1 (7.7%)	4

Note. Code values: 1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree*, 5 = *Strongly Agree*

In addition to the data summarized in Table 5, some responders provided additional comments as outlined in Table 6.

Table 6

Impacts of Digital Enablement on Daily Management Survey Additional Comments

ID	Please add any additional comments you feel would be helpful.
1	Following real time data helps us understand where we are at right this moment, it puts people in a positive place both good and bad should be seen. We do not trust the actual realtime data being presented though, updates and slow Systems Applications and Products (SAP) transactions don't really allow for that.
8	At the morning meetings it is hard to hear all the information, microphones are available but not used by everyone. The information provided does not give all the appropriate information, the information given is either the press number or work cell number but does not include what material/job is running at the location of concern or who the customer is so we can ensure the correct supporting role is aware. The digital dashboards I feel are a work in process as I feel all the information is not accurate, the training portion and the QNs on [VS2] doesn't seem to be pulling out the correct information. There are separate morning meetings for instance [VS1], [VS2] & [other customer]. When supporting multiple accounts, I am unable to attend both the [VS2] & [other customer] meetings at 8:30am
10	Accuracy of the data on the boards can be an issue. Usually due to production manually entering it, but we then go off it, but it's incorrect. Incorrect data can be worse than none.
11	None at this time.
12	Digital Dashboards are the right direction for the future

Summary

Overall, the data above will steer the direction daily management will take at Company XYZ. The data regarding the SQDC metrics shows how the selected KPI's have affected the outcomes of value streams. The survey results allow us to see how humans feel the collaboration between the digital dashboards and accountability board have helped production. The results also outline areas where there is room for improvement, which will be discussed in the next section.

Chapter V: Discussion, Conclusion and Recommendations

Company XYZ continuously faced resistance to the implementation of a tiered daily management system. In addition, digital enablement had not been implemented at the front lines of the company's operations in a collaborative manner. The transition to incorporating digital solutions with tiered daily management was assessed throughout this study.

Discussion

As outlined by the corporate team at Company XYZ, a successful tiered daily management system allows the facility to communicate necessary information with the right people at the right times. The ideal system ensures that information is communicated cross-functionally, throughout multiple shifts, and through multiple layers of the organization for issues to be addressed and escalated appropriately. The results of this study support that the outcomes of the digital enablement of the daily management structure were successful overall. Different metrics or better engagement with the metrics for safety and quality should be assessed for VS1. The data does support the dashboards and digital accountability boards may have had an impact on the delivery and cost for VS1. VS2 may need to assess their metrics for safety as well, but we can see an impact on quality and cost. In addition, the perception of the new system from the team members skews to the positive side in support of the continued use of digital dashboards and a digital accountability board in the daily management for the two value streams assessed.

Other field experts have assessed the outcomes of tiered daily management and digital enablement within manufacturing separately, but not together. The focus of tiered daily management has been on establishing guidelines for what "good" production looks like, comparing the guidelines to actual production daily, and assigning action items to individuals as

appropriate if the production metrics did not meet the standards (Mann, 2015). Studies regarding the outcomes of digital enablement in manufacturing highlight the need for management support being required for success (Lai et al., 2018). In addition, they caution against using over-customized solutions as it is hard to support these solutions long term. For this reason, it may be a good strategy for the company to establish standard guidelines for the dashboards to avoid over-customization. This literature was considered throughout the execution of this study and when developing the recommendations resulting from the study.

This study was limited by technical resources, time, and data availability. There is currently a skill gap within Company XYZ as digital enablement has not become a standard within the facility. This new daily management structure was the first attempt at site-led digital enablement solutions. In addition, IT resources are limited, so getting the displays sourced and connected was more challenging than originally anticipated. The study period limits the stabilization of the intervention, which may have skewed the data. Lastly, data availability is challenging as security requirements and vendors limit access to ERP data and machine data. While we were able to access some ERP data, it had to be cleaned and organized before use. We did not have access to machine data outside of the ERP system as vendors have not shared access rights to machine-level servers. These limits were considered throughout the study and during the analysis process.

Conclusions

The results of this study were obtained by collecting production data and survey results. Both data sources revealed that overall, integrating digital solutions with daily management seems to provide quicker communication, an increased volume of information, and an avenue for resolution to production issues. The answers to the research questions are outlined below.

Research Question 1

Research question 1 asks, “Does real-time data made available via digital dashboards influence the outcome of production?” According to the survey question outlined in Table 5, it appears that there is a perception that real-time data has an influence over the outcome of production as 76% of respondence supported this strategy. There is concern about the integrity of the data provided, which will need to be addressed to ensure sustainability of the system.

Research Question 2

Research question 2 asks, “If digital dashboards influence the outcome of production, do they create a positive or negative effect?” This question is addressed by both the metrics that fall under the SQDC framework in addition to the survey results. The metrics confirm that digital dashboards do not have a negative effect on production. In some cases, like in OEE on VS1 and scrap costs on both VS1 and VS2, we can see that the metrics improved positively after the digital intervention occurred. Additionally, the survey results in Table 5 indicate that there is a perceived positive improvement in the value streams because of the intervention as a median value of 4 out of 5 was obtained from responders when asked if real-time data had a positive effect on production. This indicates that the responders mostly agree that there is a positive effect.

Research Question 3

Research question 3 asks, “Is the tiered daily management structure enhanced by digital dashboards?” This is a more subjective question, so we can look at the survey results to determine the answer. Of those surveyed, 92.3% responders agree or strongly agree that “Incorporating digital dashboards is the right approach to our daily management structure,” as shown in Table 5. Only one responder was “neutral” to this question. Responder 12 noted

“Digital Dashboards are the right direction for the future.” Furthermore, we can look to survey answers in Table 5 to determine if the current state of the digital dashboards and digital accountability boards are producing the desired effects on the stakeholders of the value streams. Of those that responded, 69% agree that accountability has increased, although there are some responders that disagree or are neutral. From the results reviewed, we can see that those surveyed are generally satisfied with the changes applied to the daily management system.

To assess the results further, we can reference Table 5 as it assesses the responder’s perception of data integrity. The median result for the question regarding their confidence level in the integrity of the data was 4 out of a maximum amount of 5, which indicates that the responders generally agree that they have confidence in the data. However, the additional comments do outline some concerns regarding how we’re retrieving and presenting data. Responder ID 1 stated “We do not trust the actual real time data being presented though, updates and slow SAP transactions don't really allow for that.” This can be a struggle when we’re working with a monolithic ERP system where data is not easily accessible and, when it is, it is not provided in a format that allows for useful visualizations. The results from this survey question point to an opportunity that the company can focus on, which is to increase data integrity. This effort is supported by the apparent demand to continue using digital dashboards in daily management.

Research Question 4

Research question 4 asks, “Does the human collaboration with the provided digital solutions improve overall equipment effectiveness?” As outlined under the delivery section, the data indicates that there was a 2.7% increase in OEE on VS1 from the baseline period to the

observation period, which could be partially attributed to the digital enablement integrated with the tiered daily management system.

While there is support for incorporating digital solutions in the daily management system, there have been areas identified for improvement. As outlined in Table 5, 61.5% of responders felt confident in the integrity of the data behind the metrics presented in the meetings. We could hypothesize that increasing data integrity will increase action items being created to address any gaps from the pre-determined production goals. Other sources support that data integrity can be a roadblock to the success of any digital solution, which highlights that this is a roadblock that the company must overcome (Lai et al., 2018). Another metric to note regarding data is that 23% of responders disagree or are neutral about whether the data provided is meaningful. While it's great that 77% of responders believe that the data is meaningful, the company must respect the stakeholders' time and present information that will be useful for them as they start their day. Also, 69.2% of responders agreed that the digital task board increased the follow-through on action items for the value stream. The desired outcome is for there to be a consistent resolution on action items regardless of who it is assigned to and having 30.8% of responders not agreeing that the system has achieved that outcome is below the standards of the company. The most important outcome from the study is that we have been able to identify the flaws in the system, which gives the company an opportunity to address the flaws.

Recommendations

With there being overall support for the digitization of the daily management system, there are additional improvements needed to enhance the effectiveness and confidence of the system. There needs to be increased confidence in the integrity of the data presented. There also needs to be better follow-through on the action items assigned. After those two issues are

addressed, the team can determine how to expand the digital dashboards and accountability boards to the other areas in the plant.

Data Integrity and Usage

To increase data integrity, Company XYZ can take several parallel paths. First, the company can implement a real-time data fabric. Data fabric refers to the process of gaining access to usable data and making it available for integration and visualization (Blohm et al., 2024). For the purposes of daily management, this means bringing real-time machine data to the morning meetings. This is especially applicable to VS1 since it is a highly automated line. At this time, the integrity of the data is limited by manual data entry, which is subject to errors and missed entries. By connecting to the machine directly and streaming the data into a semantic model, data integrity will improve, and the cross-functional teams will feel more empowered to make decisions based on the data.

Another aspect of the study regarding the data is the relevance of the data. The leadership needs to refine what good looks like and focus on what adds value to the customer. The purpose of the data is to "…highlight when the process is not performing as expected, and thus where improvement might be needed" (Mann, 2015, p. 77). The leadership will need to identify the KPI's that are not supporting that standard and to remove or alter the KPI to meet that standard and to increase the usefulness of the data for the team. If the team finds meaning in the metrics displayed, the data can drive more action.

Accountability

It is also recommended that the groups continue to practice following-up on action items. It may be beneficial to incorporate a "red dot" on items that are in bad standing or "green dot" on action items that are in good standing (Mann, 2015). This is not meant to shame people who may

have many red dotted action items. Alternatively, the red dot can be used to determine if the value stream needs more support or needs a different subject matter expert involved in closing out the action (Mann, 2015). In addition, supervisors and managers need to refine their project management skills (Mann, 2015). The follow-through may not increase unless the leaders openly express their expectations of follow-through. Increasing follow-through will increase the effectiveness of the system.

Digital Enablement Expansion and Improvement

The last recommendation is to determine the right approach to expanding the digital dashboards to other areas of the facility. With the other areas not being value stream specific, the key metrics will not look the same as the value stream focused dashboards. The first step in the process will be to determine the key metrics that will be meaningful to the cross-functional teams and how to access that data. The next step will be to determine how to get access to that information. Lastly, a dashboard will need to be built with that data. In parallel with the system expansion, the team should continually improve the established dashboards as data accessibility and integrity improves. By using what has been learned in the study, expansion of the system should be more streamlined than the initial implementation on VS1 and VS2.

Increasing data integrity will increase trust in the data, increase the usage of the gap-to-goal metrics, and increase the act of creating action items based on the data. Exercising project management skills and focusing on resource allocation for open action items should enhance the effectiveness of the system.

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Appendix A

CITI Certification

CITI PROGRAM

Completion Date 15-Sep-2024
Expiration Date 15-Sep-2027
Record ID 65215276

This is to certify that:

Heather Dietsche

Not valid for renewal of certification through CME.

Has completed the following CITI Program course:

Social-Behavioral-Educational (SBE) Comprehensive
(Curriculum Group)
Social-Behavioral-Educational (SBE) Comprehensive
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

University of Wisconsin - Stout

CITI
Collaborative Institutional Training Initiative
101 NE 3rd Avenue, Suite 320
Fort Lauderdale, FL 33301 US
www.citiprogram.org

Generated on 15-Sep-2024. Verify at www.citiprogram.org/verify/?w52946c1b-b6c4-43e0-be52-a058834c5bba-65215276

Appendix B

IRB Approval

IRB-FY2025-217 - Initial: Approved as Exempt

From do-not-reply@cayuse.com <do-not-reply@cayuse.com>
Date Tue 4/15/2025 2:16 PM
To Aba, Eli <abae@uwstout.edu>; Dietsche, Heather <rineharth9214@my.uwstout.edu>

University of
Wisconsin-Stout
Wisconsin's Polytechnic University

INSTITUTIONAL REVIEW BOARD
Office of Research and Sponsored Programs Robert S. Swanson Learning Center #201

715-232-4042

irb@uwstout.edu

Date: April 15, 2025

PI: Heather Dietsche

Department: OPERATIONS & MANAGEMENT, GRADUATE STUDENT

Re: Initial - IRB-FY2025-217

Impacts of Digital Enablement on Daily Management in Manufacturing

Dear Heather Dietsche,

In accordance with Federal regulations, your project, Impacts of Digital Enablement on Daily Management in Manufacturing, was reviewed by a member of the University of Wisconsin - Stout Institutional Review Board and was determined to be Exempt from full review under the below Categories in accordance with Federal Policy for the Protection of Human Subjects (45 CFR 46).

Category:

You project is hereby approved and deemed exempt from further IRB review for 5 years from April 15, 2025. If a renewal of this approval is needed, it is to be submitted at least 10 working days prior to the expiration date.

Responsibilities for Principal Investigators of UW Stout IRB-approved research:

1. NO subjects may be involved in any study procedure prior to the IRB approval date or after the expiration date.
2. All unanticipated or serious adverse events must be reported to the IRB_
3. All protocol modifications must be approved prior to implementation unless they are intended to reduce risk.
4. All protocol deviations must be reported to the IRS.
5. All recruitment materials and methods must be approved by the IRB prior to being used.
6. Research which involves financial compensation to participants must follow appropriate UW Stout payment procedures.
7. Consent forms must adhere to UW Stout IRB standards and indicate that the research has been approved by the IJW Stout IRB as required by federal regulations (see UW Stout IRB consent form templates for more details).
8. Researchers conducting human subjects' research under an approved exempt category are still ethically bound to follow the basic ethical principles of the Belmont Report, as reflected in the practice of obtaining informed consent from participants and adherence to IRB approved methods.
9. Any modifications to the approved study must be submitted for review through Cayuse IRB. All approval letters and study documents are located within the Study Details in Cayuse IRB.

Thank you for your cooperation with the IRB and best wishes with your project. If you have questions, please contact the IRB office at rb@uwstout.edu or by phone 715 232 4042, and your question will be directed to the appropriate person.

Sincerely,

Michael Mensink, Ph.D.; IRB Chair

University Of Wisconsin Stout Institutional Review Board

Appendix C

Informed Consent for Research Participation

Study Title:	***Impacts of Digital Enablement on Daily Management in Manufacturing***

Researcher Names	**Department**	**Contact Information**
Heather Dietsche	M.S. Operations and Supply Management	715-933-4966

Faculty Advisor	**Department**	**Contact Information**
Eli Aba	Department of Operations and Management	abae@uwstout.edu

Overview of the Research Study

Participation invitation:	You are invited to participate in the research study described below. Your participation is entirely voluntary, and you may stop your participation or withdraw from the study at any time and for any reason. If you choose to not participate or to stop your participation, there will be no negative consequences to you. Your decision to participate or not in this study will not change your relationship with the researchers or the University of Wisconsin-Stout.
Who can participate in this study:	If this questionnaire is sent to you and you consent to be included, you can be included in this study.
Study description:	The purpose of this study is to analyze the effects of digital enablement on manufacturing processes and outcomes.
What you will be asked to do:	Simply complete this survey has honestly as possible.
Time commitment:	Approximately 5 to 10 minutes to complete the survey.

Participation risks:	The researcher does not believe this study will cause you any discomfort or other risk beyond what you would normally experience in your daily life.
What will be done to minimize your participation risks:	N/A
Participation benefits:	Participation in this study will allow the researcher to better understand the digital collaboration process and determine tools that best fit the facility practices, processes, and culture.

Confidentiality and Data Protection

Who will have access to your data:	Survey responses will be included in the research report of this study. Your name will be replaced with a unique identifier. No personal identifiable information will not be disclosed.
Data protection and future use:	Personal identifiable information (PII) will not be disclosed. Any PII provided by submitting this form will be removed and replaced with a unique identifier for traceability purposes only.

Protection of Human Research Subjects

If you have questions about this study, please contact:	Heather Dietsche
If you have concerns about this study or your rights as	Institutional Review Board Chair University of Wisconsin-Stout Robert S. Swanson Learning Center #207

a participant, please contact:	715-232-4042 irb@uwstout.edu
Your right to withdraw:	Your participation in this survey is entirely voluntary. You may choose not to participate or to stop the survey without any adverse consequences to you. Once you submit your responses, the data will be provided to the researcher who will remove any PII before presenting the data in a research report, at which time consent cannot be withdrawn.
UW-Stout IRB approval statement:	This study has been reviewed and approved by the University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations for human subjects research as required by federal law and UW-Stout policies.

Consent Statement

I agree to participate in this study and understand that I may stop my participation or withdraw my consent at any time during active participation.

☐ I consent for my responses to be included in the study

☐ I DO NOT consent for my responses to be included in the study

Signature of participant[1] **Date**

[1]Electronic signature retrieved via Office 365 Account.

Appendix D

Digital Enablement and Daily Management Integration Survey

Study Title:	***Impacts of Digital Enablement on Daily Management in Manufacturing***

Researcher Names	**Department**	**Contact Information**
Heather Dietsche	Operational Excellence	715-933-4966

Faculty Advisor	**Department**	**Contact Information**
Eli Aba	Department of Operations and Management	abae@uwstout.edu

Section 1: Background

5. What cross-functional team best matches your position?
    a. Production
    b. Maintenance
    c. Warehouse
    d. Quality
    e. Manufacturing/other Engineering
    f. Management
6. How many years of experience do you have in the medical device or medical diagnostics manufacturing industry?
7. How many years of experience do you have at this company?

Section 2: Tiered Daily Management Reflection

1. Select the option that best represents your opinion on the following statement: Incorporating digital dashboards is the right approach to our daily management structure.

Very Untrue	Mostly Untrue	Neutral	Mostly True	Very True

2. How do you feel about the usefulness of the data presented in the morning meetings?

Extremely Unhelpful	Unhelpful	Neutral	Helpful	Very Helpful

3. How confident do you feel about the integrity of the data presented in the meetings?

Not confident at all	Not very confident	Neutral	Mostly confident	Extremely confident

4. Select the option that best represents your opinion on the following statement: Incorporating a digital task board has increased the traceability and follow through on daily action items.

Very Untrue	Mostly Untrue	Neutral	Mostly True	Very True

5. Does real-time data made available via digital dashboards influence the outcome of production?
    a. Yes
    b. No
    c. Unsure

6. If the digital dashboards influence the outcome of production, do they create a positive or negative effect?
    a. Yes
    b. No
    c. Unsure

7. Select the option that best represents your opinion on the following statement: The tiered daily management structure is enhanced by digital dashboards and digital task boards.

Very Untrue	Mostly Untrue	Neutral	Mostly True	Very True

8. Please add any additional comments you feel would be helpful.

Appendix E

Raw Data

ID	Consent Statement	What cross-functional team best matches your position:	How many years do you have in the medical device or medical diagnostics manufacturing industry?	How many years of experience do you have at this company?	Incorporating digital dashboards is the right approach to our daily management structure.	The data presented in the morning meetings is useful.
1	I consent for my responses to be included in the study	Production	17	17	Agree	Agree
2	I consent for my responses to be included in the study	Warehouse	34	24	Agree	Agree
3	I consent for my responses to be included in the study	Quality		23	Agree	Agree
4	I consent for my responses to be included in the study	Management	13	13	Strongly agree	Strongly agree
5	I consent for my responses to be included in the study	Production	6.5 years	6.5 years	Agree	Agree
6	I consent for my responses to be included in the study	Warehouse	15	15	Agree	Agree
7	I consent for my responses to be included in the study	Production	3.5	3.5	Agree	Disagree
8	I consent for my responses to be included in the study	Quality	26	26	Agree	Neutral
9	I consent for my responses to be included in the study	Quality	5	5	Agree	Disagree
10	I consent for my responses to be included in the study	Quality	12	10	Strongly agree	Agree
11	I consent for my responses to be included in the study	Manufacturing/other Engineering	3	3	Strongly agree	Agree
12	I consent for my responses to be included in the study	Manufacturing/other Engineering	14	14	Strongly agree	Agree
13	I consent for my responses to be included in the study	Team Leader	27 years	27 years	Agree	Agree

ID	I feel confident in the integrity of the data presented in the meetings.	Incorporating a digital task board has increased the traceability and follow through on daily action items.	The tiered daily management structure is enhanced by digital dashboards and digital task boards.	Does real-time data made available via digital dashboards influence the outcome of production?	Does having real-time data presented produce a positive or negative effect on production results?	Please add any additional comments you feel would be helpful.
1	Disagree	Disagree	Agree	Yes	Positive	Following real time data helps us understand where we are at right this moment, it puts people in a positive place both good and bad should be seen. We do not trust the actual realtime data being presented though, updates and slow SAP transactions don't really allow for that.
2	Agree	Agree	Agree	Maybe	Unsure	
3	Disagree	Agree	Agree	Yes	Positive	
4	Agree	Strongly agree	Strongly agree	Yes	Positive	
5	Agree	Strongly agree	Agree	Yes	Positive	
6	Agree	Agree	Agree	Yes	Positive	
7	Disagree	Agree	Agree	Maybe	Positive	
8	Agree	Neutral	Neutral	Maybe	Unsure	At the morning meetings it is hard to hear all the information, microphones are available but not used by everyone. The information provided does not give all the appropriate information, the information given is either the press number or work cell number but does not include what material/job is running at the location of concern or who the customer is so we can ensure the correct supporting role is aware. The digital dashboards I feel are a work in process as I feel all the information is not accurate, the training portion and the QNs on [VS2] doesn't seem to be pulling out the correct information. There are separate morning meetings for instance [VS1], [VS2] & [other customer]. When supporting multiple accounts, I am unable to attend both the [VS2] & [other customer] meetings at 8:30am
9	Agree	Agree	Agree	Yes	Unsure	
10	Disagree	Neutral	Agree	Yes	Positive	Accuracy of the data on the boards can be an issue. Usually due to production manually entering it, but we then go off it, but it's incorrect. Incorrect data can be worse than none.
11	Strongly agree	Strongly agree	Agree	Yes	Positive	None at this time.
12	Neutral	Neutral	Agree	Maybe	Positive	Digital Dashboards are the right direction for the future
13	Agree	Agree	Agree	Maybe	Positive	

VS1 OEE by Date				
Date	Overall OEE	POEE	QOEE	AOEE
4/3/2025	50.83333	74.93333	95.63333	70.36667
4/4/2025	37.45	65.9	96.6	57.15
4/5/2025				
4/6/2025				
4/7/2025	49.35	79.25	88.8	65.4
4/8/2025	50.5	81.3	96.7	64.3
4/9/2025	60.4	87.05	97.1	71.4
4/10/2025	59.25	87.35	96.55	70.2
4/11/2025	55.75	86.3	97.05	66.4
4/12/2025				
4/13/2025				
4/14/2025	58.425	87.775	95.075	74.425
4/15/2025	53	86.1	95.56667	64.36667
4/16/2025	58.73333	87.16667	95.43333	70.6
4/17/2025	46.5	87.6	95.4	55.6
4/18/2025	57.03333	87.03333	97.2	67.36667
4/19/2025				
4/20/2025				
4/21/2025	57.1	87.125	95.4	68.725
4/22/2025	62.75	87.35	97.15	73.85
4/23/2025	57.76667	87.46667	97	67.93333
4/24/2025	49.3	86.675	96.625	58.75
4/25/2025	58.3	84.7	98.8	69.7
4/26/2025				
4/27/2025				
4/28/2025	41.9	81.5	98.7	51.45
4/29/2025	61.13333	86.1	98.2	72.23333
4/30/2025				

VS2 Output by Date	
Date	Devices Made
4/4/2025	3
4/5/2025	1
4/6/2025	2
4/7/2025	14
4/8/2025	22
4/9/2025	3
4/10/2025	13
4/11/2025	12
4/12/2025	19
4/13/2025	11
4/14/2025	5
4/15/2025	6
4/16/2025	9
4/17/2025	16
4/18/2025	6
4/19/2025	5
4/20/2025	9
4/21/2025	10
4/22/2025	19
4/23/2025	9
4/24/2025	5
4/25/2025	3

VS2 Test 1 Yield by Date	
Date	Test 1 Yield
4/3/2025	64.70%
4/4/2025	50.00%
4/5/2025	32.50%
4/6/2025	41.40%
4/7/2025	48.60%
4/8/2025	35.50%
4/9/2025	51.90%
4/10/2025	59.50%
4/11/2025	81.50%
4/12/2025	57.10%
4/13/2025	80.00%
4/14/2025	67.70%
4/15/2025	35.00%
4/16/2025	51.40%
4/17/2025	66.70%
4/18/2025	67.70%
4/19/2025	48.00%
4/20/2025	64.90%
4/21/2025	55.30%
4/22/2025	70.00%
4/23/2025	37.90%
4/24/2025	43.80%
4/25/2025	56.70%
4/26/2025	51.60%
4/27/2025	43.30%
4/28/2025	50.00%
4/29/2025	40.00%

VS2 Test 2 Yield by Date	
Date	Test 2 Yield
4/4/2025	31.30%
4/5/2025	42.90%
4/6/2025	52.60%
4/7/2025	100.00%
4/8/2025	100.00%
4/9/2025	38.50%
4/10/2025	100.00%
4/11/2025	91.20%
4/12/2025	96.20%
4/13/2025	100.00%
4/14/2025	52.20%
4/15/2025	91.70%
4/16/2025	90.90%
4/17/2025	100.00%
4/18/2025	57.90%
4/19/2025	71.40%
4/20/2025	73.10%
4/21/2025	87.90%
4/22/2025	81.80%
4/23/2025	74.10%
4/24/2025	87.50%
4/25/2025	94.40%
4/26/2025	93.90%
4/27/2025	89.50%
4/28/2025	80.00%
4/30/2025	97.10%