An Integrated Web-based Scheduling and Quality Decision Support System (SQDSS)

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ABSTRACT

Decision Support Systems (DSS) have evolved from being considered as a competitive edge to a survival strategy. In different echelons of a value chain, when DSS is combined with lean tools it drives out not only the non-value added activities (muda a.k.a. waste) from the process but also provides a decision making tool at the hands of the people. In this paper, a successful implementation of a Scheduling and Quality Decision Support System (SQDSS) at a service sector, a direct mail (letter shop) company is explained. The two primary benefits garnered were (1) attainment of 100% scheduled delivery date adherence with less rework, and (2) a seamless communication platform across the value chain to see quality defects, plan the work, and to make the product flow efficiently across the value stream. The unique contribution of this work is the original implementation of a web based decision support system that was the backbone of reducing the complexity of scheduling and improving the quality of service delivery in a high variety and low volume letter shop environment.

1. INTRODUCTION

Toyota Production System (TPS) paradigm lays the foundation to various lean manufacturing initiatives and one such fundamental building block is the continuum of Continuous Improvement (CI). According to a recent US Department of Defense report, "Continuous Process Improvement provides organizations a method for analyzing how work is currently being done and how processes can be improved to do the job more efficiently and effectively on an ongoing basis"[1]. There are many CI tools such as 5S, Kanban, Heijukna, Kata, Hoshin Kanri, Standard work, Value Stream Map (VSM), and Overall Equipment Effectiveness (OEE) that are used to identify 'muda' in manufacturing and service sectors[2–4]. "Lean Manufacturing" and "Lean" are used as synonyms, because of the broader application of the core TPS principles to various industry sectors. The recipe for successful lean implementation depends on the integration of people, process, and technology that drives out muda, mura, and muri resulting in bottom line cost benefits. Lean addresses the people and process facets by scheduling resources to utilize available process capacity and decision support system addresses the technology facet. The focus of this paper is to enumerate the development and successful implementation of an integrated model of two decision support systems: the scheduling and the quality systems. The model was designed to fit the needs of a direct mail marketing company which is an assemble-to-order system where customers own the inventory. The company provides value added service by assembling the components and sending it to end customers. This paper is organized as follows. First, we provide a brief overview of the relevant literature followed by an overview of the letter shop process. Next, we present the integrated model of the scheduling and quality decision support system and implementation of the SQDSS. Finally, the benefits and lessons learned from the implementation are summarized along with future research.

2. LITERATURE REVIEW

In Japanese, the word "Kanban" means a visual board. It is used to control inventory levels. In the production and operations world, there exist various types of kanban and optimization approaches [5–15]. Lage Junior, presented a comprehensive classification of various adaptations of kanban along with their relative strengths and weakness [13].

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The original concept of kanban is based on four components : (1) use of two communication signals (dual card kanban system), (2) pulled production, (3) decentralized control, and (4) limited Work in Process WIP [13] . There are many disadvantages of using paper kanban such as unfriendliness to the information system, complex to maintain for small production run, and not being real time[16] . One of the most recent adaptations of kanban is the web based kanban system or e-Kanban [8], [16]. The chief benefit of the e-kanban is its ability to integrate with the existing Enterprise Resource Planning (ERP) system and provide a visual interface [16].

Decision Support Systems (DSS) have been in existence since the proliferation of computers and it has been used as an enabler for business decision-making [17]. DSS's serve the management, operations, and planning levels of an organization and help to make decisions, which may be rapidly changing and not easily specified in advance [15]. Shim et.al [18] provides a comprehensive overview of DSS technology. DSS that act as decision support tools could range from simple to complex simulations[19] . Next generation DSSs' are mainly web enabled and thus could be delivered to any device that can access the web. This can significantly increase end users' acceptance and usability [1], [18–20].

3. METHODOLOGY

3.1. OVERVIEW OF LETTER SHOP PROCESS

Job shop scheduling in a print shop is a complex process due to the volume and high variety of products. Figure 1 shows a high-level overview of the letter shop process. The process starts after a successful bid to deliver services. From the client, the customer service (CS) receives the job instruction and the warehouse receives the material. The scheduling team manually schedules the job and allows the CS team to create the Work Order (WO). The production team processes the work based on the WO and the quality team audits the WO to make sure that the job is completed per the client specifications. With the final mailing statements, the warehouse ships the final product through the optimized distribution channel. On an average the scheduling team evaluates about 120 activities across 55 unique client jobs. This becomes an intense and time consuming process. The focus of this research was to reduce the scheduling complexity and improve the quality assurance of the process that has been highlighted in Figure 1 (Scheduling a Job, Production Process, and Quality Non-conformance).

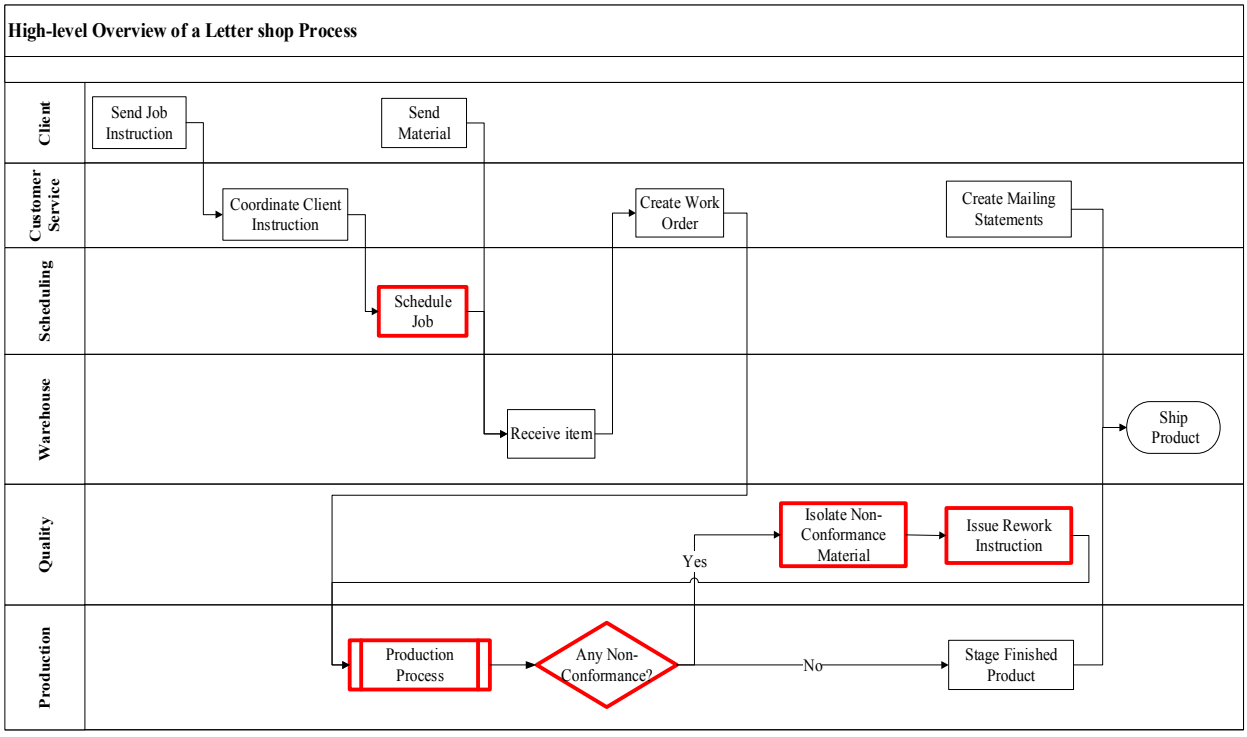


Figure 1. High-level overview of Letter Shop process.

3.2. INTEGRATED SCHEDULING AND QUALITY DECISION SUPPORT SYSTEM

Figure 2 shows the integrated model of the Scheduling and Quality Decision Support System (SQDSS). The model has four distinct modules. They are: (1) Product Status Database, (2) Existing ERP, (3) Quality Database, and (4) Decision making reporting tools.

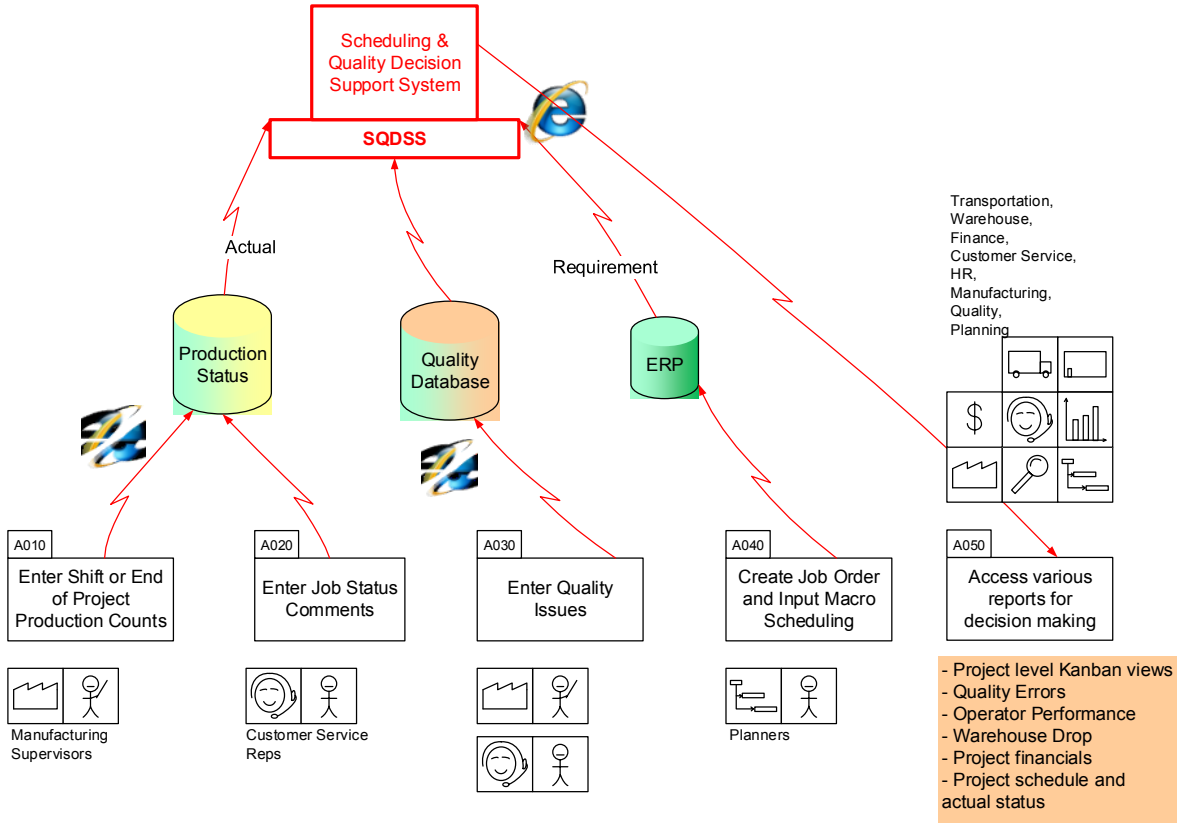


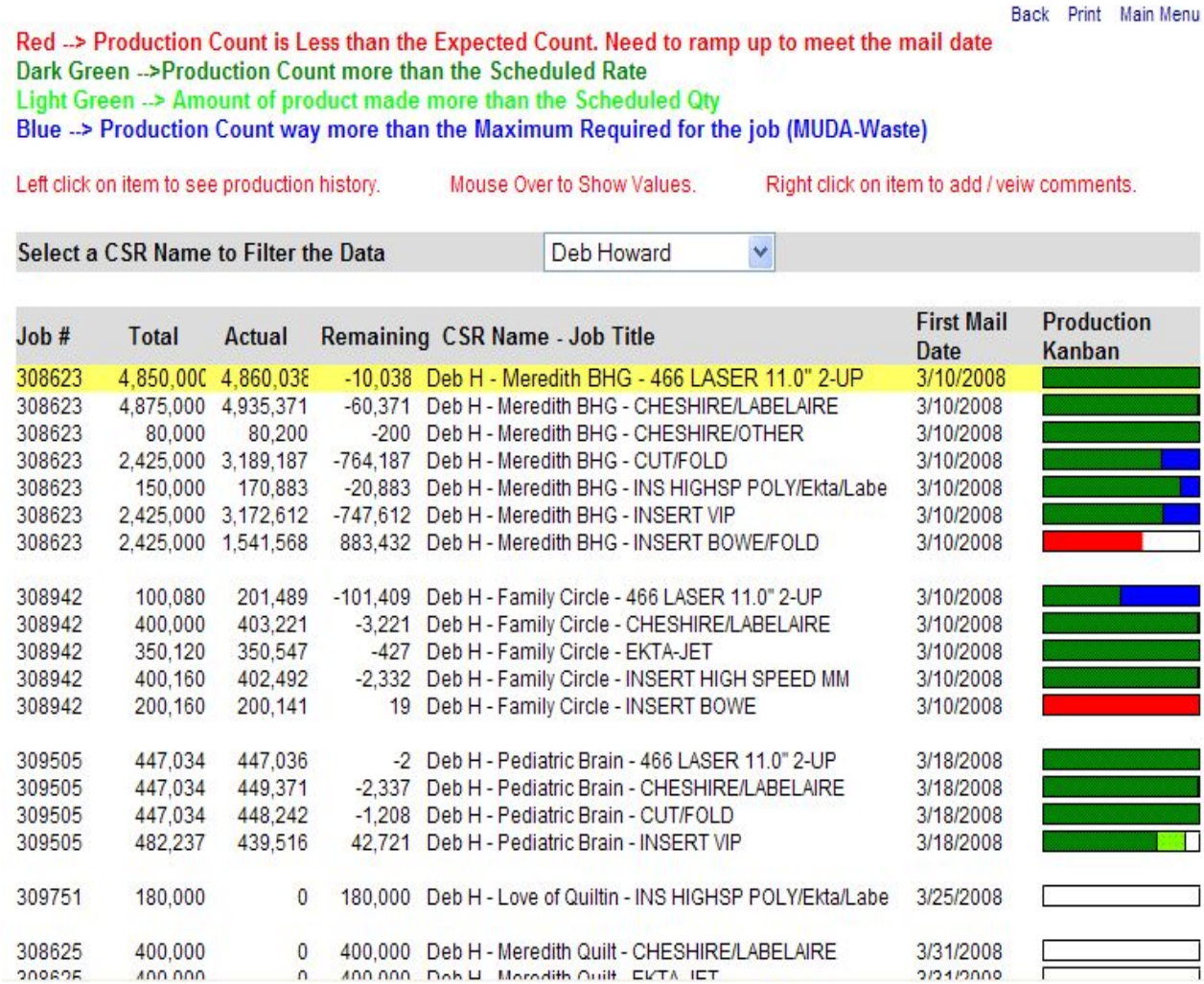
Figure 2. Integrated Scheduling and Quality Decision Support System (SQDSS) Model.

On any given day, based on the project due date, and by number of tasks to be performed, the first two module of the system houses two critical data for the decision support system: (1) Actual production quantities, by date, entered into the system by the Front Line Supervisors (FLS), and (2) Requirement quantities, by date, obtained from the existing Enterprise Resource Planning (ERP) system. The scheduling team enters quantities to be produced, and sequence of activities to be performed to complete the job order. The third module is the quality error reporting module that supports the Corrective and Preventive Action (CAPA) for the ISO 9000:2001 Quality Management System (QMS). This comes into play during the quality audit performed during the production process. The information about the job and the relevant production metrics are pulled from the first two modules and allows the customer service representatives and the FLS to enter any first pass setup, or material issues. It acts as the trigger for the quality team to follow up and resolve the issues. The last module is the decision support system that caters to a wider audience and enables departments to be effective and efficient in executing their tasks.

4. IMPLEMENTATION

The central feature of the scheduling piece of SQDSS is the web-based kanban. Figure 3 show the web-based kanban sorted by job and then by First Mail Date (FMD) which is a critical customer requirement and constitutes the schedule adherence metrics. It provides an actual view of project progress and visually depicts the status. It also has drill-down capabilities at the task level that provide options for the production and scheduling team to make informed decisions. Each activity is represented as a "Kanban". The different color of the kanban represents the following: Red → production count is less than the expected count and need to ramp up to meet the mail date. Dark Green → total

production count is more than the expected completion quantity indicating that overall process is ahead than scheduled, Light Green →Production rate is more than the scheduled rate indicating higher process efficiency, Blue → Total production count is more than the job quantity indicating muda "Over Production". In Figure 3, the job 308623 and job 3089420 has task "Insert Bowe" red because it is running behind by the expected end counts. On contrast, job 309505 "Inset VIP" is making great progress exceeding the standard run rate and hence has dark green and light green fill. Job 308942 has one task (Laser 11" 2 up) that has lot of muda (about 101,409 pieces overproduced than requirement) while another task is lagging behind the anticipated due date. During the daily production meeting the customer service, production, quality, and warehouse management team review this information to make necessary management decisions. The front line supervisors have the ability to review this updated information on an hourly basis.



Job #	Total	Actual	Remaining	CSR Name - Job Title	First Mail Date	Production Kanban
308623	4,850,000	4,860,038	-10,038	Deb H - Meredith BHG - 466 LASER 11.0" 2-UP	3/10/2008	
308623	4,875,000	4,935,371	-60,371	Deb H - Meredith BHG - CHESHIRE/LABELAIRE	3/10/2008	
308623	80,000	80,200	-200	Deb H - Meredith BHG - CHESHIRE/OTHER	3/10/2008	
308623	2,425,000	3,189,187	-764,187	Deb H - Meredith BHG - CUT/FOLD	3/10/2008	
308623	150,000	170,883	-20,883	Deb H - Meredith BHG - INS HIGHSP POLY/Ekta/Labe	3/10/2008	
308623	2,425,000	3,172,612	-747,612	Deb H - Meredith BHG - INSERT VIP	3/10/2008	
308623	2,425,000	1,541,568	883,432	Deb H - Meredith BHG - INSERT BOWE/FOLD	3/10/2008	
308942	100,080	201,489	-101,409	Deb H - Family Circle - 466 LASER 11.0" 2-UP	3/10/2008	
308942	400,000	403,221	-3,221	Deb H - Family Circle - CHESHIRE/LABELAIRE	3/10/2008	
308942	350,120	350,547	-427	Deb H - Family Circle - EKTA-JET	3/10/2008	
308942	400,160	402,492	-2,332	Deb H - Family Circle - INSERT HIGH SPEED MM	3/10/2008	
308942	200,160	200,141	19	Deb H - Family Circle - INSERT BOWE	3/10/2008	
309505	447,034	447,036	-2	Deb H - Pediatric Brain - 466 LASER 11.0" 2-UP	3/18/2008	
309505	447,034	449,371	-2,337	Deb H - Pediatric Brain - CHESHIRE/LABELAIRE	3/18/2008	
309505	447,034	448,242	-1,208	Deb H - Pediatric Brain - CUT/FOLD	3/18/2008	
309505	482,237	439,516	42,721	Deb H - Pediatric Brain - INSERT VIP	3/18/2008	
309751	180,000	0	180,000	Deb H - Love of Quiltin - INS HIGHSP POLY/Ekta/Labe	3/25/2008	
308625	400,000	0	400,000	Deb H - Meredith Quilt - CHESHIRE/LABELAIRE	3/31/2008	

Figure 3. Web based Kanban.

Figure 4 provides an overview of various modules of this decision support system. It has about 9 different areas such as Production Performance (Various reports that gauges the efficiency of the process, and machines), Scheduling (Kanban with choice of decisions - either increasing the number of machines that can be run in parallel or increasing number of people on a machine for that activity, Floor plans-Machine layout, Open capacity), Customer Service (Provide a job drop calendar, comments about jobs for communication), Distribution (Flow of job), Warehouse (Receiving material entry, Daily efficiency), Quality (Quality error reports, Overall quality performance), Presort & Programming (Postal Equipment Entry), Human Resources (Employee Absent tracking, Employee Overall Performance including efficiency and quality rate) and Metrics/Reports (Financial performance of job for various clients, Revenue, invoice status). The focus of this paper is only the Quality and Scheduling modules.

Figure 4. View of Scheduling and Quality Decision Support System (SQDSS) with menu options.

Figure 5 show the quality error reports. Periodic audits are conducted and the non-conforming finished products are isolated. Error that caused the non-conformance is identified and entered into the system; quality team routinely checks this report and acts on it. They perform the root cause analysis and issue needed re-work instructions. Upon rectifying the errors, the FLS coordinates the signoff with quality and the status of the re-work is updated. For example, in job 311162 has an excessive blank material. Upon investigation, it was found that the operator ran through the "test material marked with magic marker" that got mixed up with the finished product. The complete details of the error including the operator information (employee number, shift, date and time), machine information (machine number, area, and task), job information (customer service rep, quantity, and mail date), and quality issues are captured in the decision support system. This serves two purpose (1) quick decision making process to evaluate the urgency of the situation, as the key to this identification is to understand the impact to mail date (2) historic job quality performance tracking that helps the schedulers and the pricing agents to consider this when the company bids for the prospective jobs. The old process of reporting a quality error was to fill in a spread sheet and send it to a group comprising of quality, customer service, and production people. This data is then entered into a database for tracking. Often, the communication about the problem was not clear. Furthermore, there was no visibility of problems across the upstream and downstream process. The new system totally eliminated the duplicate entry of data. It had checks and balances for data in-consistency. The user-friendliness became a major success as number of errors reported jumped to all record levels. It helped the organization to catch the errors before the product was shipped.

5. RESULTS & DISCUSSION

The SQDSS helped the FLS to know how they are progressing towards their scheduled production goals. When the kanban is red, the system aided the supervisor to make appropriate decision to increase people or machines to meet the scheduled delivery dates. As the system evolved, the users incorporated it into their day-to-day activities. It helped them to make many of their daily decisions easier. Some of the decisions are: who are the best operators of specific machines and how did a machine perform over time on a given job. It helped them to plan and identify the best machine that a job can run by effectively utilizing people and equipment. It improved the communication of what job to run next during off shifts and reduced the scheduling time from 180 minutes to 63 minutes. Production operations management teams on a daily basis need to know how much to make and how much is made to meet the schedule delivery date.

SQDSS provided an operations decision system for managers and first line supervisors. It eliminated hours of data duplication. It also provided a common communication platform for off-shift operations. The system eliminated duplicate Microsoft Excel spread sheets and paper copies of production report, from three spread sheets to zero spread sheets. It reduced planning time from 195 minutes to 60 minutes per day. It also eliminated the planning team's employee turn-over. It eliminated the tribal knowledge of schedulers. The machines needed to complete the job on-time were calculated more scientifically, resulting in improved data accuracy. It surfaced all mistakes in production data entry and provided centralized communication across customer service representatives, production and planning team. A single face of truth job information update was provided. Along with all the above benefits, it created clear visibility across off-shifts and helped to achieve 100% on-time delivery, meeting the FMD.

Click Here to Enter New Quality Error

Click on area to view and print the complete Error with details

Area	CSR	Job Title	Job #	Pkg	Quantity	Er. Date	Shift	Mail Date
Forms Conversion	Becky M	HFC Big Dog Gift Campaign	311162	12	150	7/23/2009	Ev	8/17/2009
Excessive blanks found. Most had magic marker scribbled through them signifying end of a roll or beginning. This operator should have pulled them								
		Error Identified	MP0TRD0		7/23/2009 2:47:09 AM			
		Re-Work Inst. Issued	MP0LDS0		7/23/2009 12:05:18 PM			
Laser	Deb How	Meredith Kraft	311408	1	240	7/21/2009	Da	7/24/2009
Operator re-printed 240 pieces.								
		Error Identified	MP0KWA0		7/21/2009 1:34:41 PM			
		Re-Work Inst. Issued	MP0LDS0		7/22/2009 3:02:39 PM			
		Re-Work Inst. Updated	MP0LDS0		7/22/2009 3:02:47 PM			
Personalization	Holly N	Prudent GUC401.2	312072	1	1	7/20/2009	Ev	7/30/2009
Operator from addressing marked the box tags as 312073 instead of 312072. This could have resulted in a huge error if it had not been caught.								
		Error Identified	MP0LSW0		7/20/2009 5:38:16 PM			
		Re-Work Inst. Issued	MP0LDS0		7/21/2009 9:47:17 AM			
Forms Conversion	Becky M	HFC Big Dog Gift Campaign	311162	12	150	7/17/2009	Ev	8/17/2009
Excessive blanks in the addressing trays. Approx 150 blanks were found in 2 trays of addressing. Some of the blanks had magic marker on them signifiying beginning or ending of a roll in lasers.								
		Error Identified	MP0TRD0		7/20/2009 6:28:52 AM			
		Re-Work Inst. Issued	MP0NAR0		7/20/2009 4:26:56 PM			

Figure 5. Quality Error Reports.

6. CONCLUSION & FUTURE RESEARCH

Lessons learned from the lean decision support system were instrumental in setting the continuous improvement road map. The buy-in from people across all levels, particularly the "Senior Leadership Team" was pivotal. The "What is in it for me" factor was addressed by the user-friendliness of the reporting features of DSS and by genuinely driving the muda out of the process. It helped the implementation by winning over the confidence that the system was able to provide accurate information at the hands of the people when they want it. The company realized 100% adherence to the scheduled delivery dates with higher quality product. Upon the success of the pilot system, the implementation was expanded to three additional facilities across America. It could be concluded that by combining the lean and DSS concepts, it is possible to eliminate muda and provide improved collaboration and communication, resulting in bottom line profits. This work is part of an ongoing research on how web based decision support system enables an organization to eliminate muda and truly lays the foundation for a culture of process excellence. We are also in the early stages to expand the work further to other service sectors under a wider paradigm of how to synchronize people, process and technology with purpose.

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