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Building RMA Process for an Electronic Manufacturing Company: A Case Study

Basel Sultan and Daryl Santos
Thomas J. Watson College of Engineering and Applied Science
Systems Science and Industrial Engineering Department
Watson Institute for Systems Excellence (WISE)
The State University of New York at Binghamton
Binghamton, NY 13902, USA
bsultan2@binghamton.edu, santos@binghamton.edu

Thomas Byrnes
Foxconn Industrial Internet
Mount Pleasant, WI 53177, USA
thomas.byrnes@fii-usa.com

Abstract

Return merchandise authorization (RMA) provides a tremendous impact on product quality, customer satisfaction, and the level of customer loyalty and retention. In this work, increased attention is given to the supply chain process sustainability, generally, and the RMA process, specifically. This paper explains the effort spent on developing and improving the RMA process for an electronic manufacturing company in the USA. This includes building the process flow, Systems, Applications and Products in Data Processing (SAP) linkage, organizational chart, releasing standard operating procedure (SOP), designing structural layout, building the communication channels, defining customer induced damage (CID) and vendor induced damage (VID) regulations, and building the proper computer integrated manufacturing system (CIMS) to monitor and control the built process.

Keywords
Reverse logistics, return merchandise authorization (RMA), computer integrated manufacturing system (CIMS), standard operating procedure (SOP), and systems, applications and products in data processing (SAP).

1. Introduction
From the early 2000s, the field of sustainable operations management emerged as a way to bring supply chain economics, social issues, and environmental concerns together under one umbrella (Sultan et al. 2023). The main drivers for this focus on supply chain sustainability were the rapid pace of production and consumption aided by advanced technologies, and the increasing customers' demands.

The triple bottom line (TBL) aspects of economic prosperity, environmental protection, and societal well-being must be taken into account when developing a sustainable RMA process (Metta and Badurdeen 2013). Additionally, a holistic and systems-based approach that views the RMA process starting from receiving the product back from the customer to either sending it back after repairing, or scrapping it if it is unrepairable, and a cradle-to-cradle philosophy for closed loop material flow must also be taken into account.

Three interdependent factors or subsystems can be taken into account when building a team: a social or people subsystem, a technical subsystem consisting of tools, techniques and knowledge, and an environmental subsystem that includes customers. That is, besides turning the traditional management structure of building teams into a newer one that focuses on the design of work and the interface between technical systems and workers (Becker 2013).

This paper describes the effort expended on developing an RMA team and associated RMA processes for an electronic manufacturing company in the USA. This effort includes experts' actual experience, engineers' technical knowledge, and some of the engineering methods applied by the researchers. Significant efforts have united to put in place an RMA process for this electronic manufacturing company.

1.1 Objectives

The main objectives of the study are the following:

- Defining the RMA process for one of the products in a semiconductor manufacturing company.
- Officially releasing the required documents to standardize the developed RMA process.
- Maintaining and optimizing the product, financial and information flows for RMA process by building the adequate networks.
- Increasing the customers' satisfaction by building the RMA process that meets their needs.

2. Literature Review

In the 1990s, the business, environment, industrial ecology, and industrial ecosystem research started to grow. All this research directly influenced the supply chain sustainability to grow. And during that time, the term "supply chain management" started to gain popularity among researchers. During the same period, the concept of sustainability started to gain its own popularity among researchers. Sustainability history ranged from an inter-generational philosophy to a multi –dimensional term. The first term works on making sure that future generations are not negatively getting affected by our current decisions. While the second one covers subjects pertaining to the "triple-bottom-line" of balancing corporate social responsibility, such as balancing sustainability's social, environmental, and economic aspects (Seuring et al. 2008).

Globalization trends and information technology advancements have made cross-border collaborative manufacturing possible. These developments are leveraged by a dynamic supply chain to provide increased flexibility in corporate cooperation (Chai et al. 2010). In order to integrate sustainability into company operations, sustainable systems, procedures, and products are needed. In order to sustain profitability and effectively mitigate the environmental and social implications of supply chains (SCs), the entire SC must be planned and operated from a full life-cycle perspective, taking into account product, process, and SC design coordination, both forward and reverse flow (Metta et al. 2013). Reverse logistics and green product design are green supply chain management practices that are being implemented to demonstrate a firm's commitment to sustainability (Khor and Udin 2013). Reverse logistics, according to Hervani et al. (2005), is an operational procedure that gathers materials for re-entry at the forward supply chain via recycling, remanufacturing, or reuse in order to create new or used products.

Organizations are now forced by competitive forces to turn elsewhere for guidance on maintaining a sustained competitive advantage. Systems for inter-organizational performance management are involved (Hervani et al. 2005). Winter and Knemeyer (2013) stated that future research opportunities are suggested, both generally and more specifically, based on an analysis using a literature-based classification matrix constructed on the two axes of "sustainability dimensions" and "SCM elements." The analysis highlights areas for further research as well as giving academics and practitioners a summary of the body of work already done in this field. They also hoped by having a better grasp of the features of the body of existing literature about supply chain sustainability and some of the suggested research avenues that were put forth, researchers will be more equipped to proactively carry out research on sustainable supply chain management to assist businesses and society in this significant matter.

Automation technology development is an ongoing evolutionary process that has generated excitement for many years. Increased supply chain flexibility along with cost advantages are motivating the introduction of CIMS to the supply chain process. Due to the current customer oriented environment, it is imperative to take advantage of these cost advantages that arise from process integration and streamlining. This cannot be done without increasing the process flexibility which can be achieved by engaging computer applications (Scheer 1994).

3. Methods

The methodology for this study starts from the idea that the company that this study was conducted on has no SOP for RMA. This is not to say that they did not have an RMA process, but each return was separately handled and was a tedious and manual process. A major purpose of this effort was to develop RMA SOPs, with automated functionality, and develop an RMA team. The study started by defining the problem that needs to be solved. Defining the problem comes after several meetings with the customer and hearing their needs. Figure 1 shows the steps were followed to build the required RMA process.

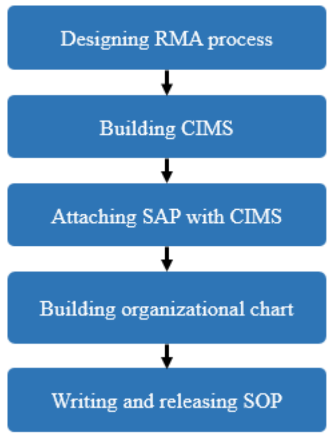


Figure 1. The Research Strategy Used for Building RMA Process for an Electric Manufacturing Company in USA

3.1. Designing RMA Process

After multiple brainstorm meetings and discussions, a flow chart process was drawn for the RMA process. This process is shown in Figure 2. The process starts with the customer sending an RMA request explaining the origin and destination locations. The origin location is where the defect product is returning from. The customer is in multiple locations so it must identify where the defect product is returning from in the RMA request file. The *RMA Coordinator* receives the RMA request and makes sure that each serial number (SN) mentioned in the request is under warranty and has been shipped depending on the shipping date in the database. Once the *RMA Coordinator* makes sure all SNs are under warranty and validated, the coordinator generates and sends the RMA number back to customer. The customer packages the defective product and ships it to the warehouse receivers with an RMA number attached to it. The *WH Receivers* make sure that the SNs in the package are matching the RMA number attached to the package. If not, the package will be sent back to the customer and the customer will pay the shipping costs. If the SNs match the RMA number, the *RMA Coordinator* releases the Work Order (WO).

Once the WO is released, the products moves to the *Incoming AOI*. The primary purpose of AOI in the Printed Circuit Board Assembly (PCBA) manufacturing is to inspect and identify defects in the assembled circuit boards. This includes checking for issues such as soldering defects, missing components, incorrect placements, and other anomalies that may affect the functionality and reliability of the PCB. If the defect exists in the previous image before it was shipped from the facility to the customer, this means the damage was internally caused and will be referred to as vendor induced damage (VID). Otherwise, it is called customer induced damage (CID). The decision whether the defect is CID or VID does not make a difference in the process. This is needed for future research purposes. If the product passes *Incoming AOI*, it moves to *Functional Board Test (FBT)*. *FBT* is a crucial step in the quality control process of PCBAs during electronics manufacturing. *FBT* is designed to verify that the assembled circuit board functions as intended and meets the specified performance requirements. This test involves checking whether the electrical circuits and components perform their specified functions within the system. But, if the product fails in *Incoming AOI*, it moves directly to *Repair* where manual or automatic repair or replacement of damaged components takes place. For the product to fail *FBT* it has to fail three times. If the product fails *FBT* it moves to the Failure Analysis (FA) Engineer who takes the responsibility of identifying and understanding the root causes of failures or issues in electronic circuits. The FA Engineer moves the product either back to repair, *FBT*, or to the *Quality Engineer* with a scrap ticket. Once the product passes the *FBT,* it goes to *Packing AOI,* then *Packing* and *Palletizing.*

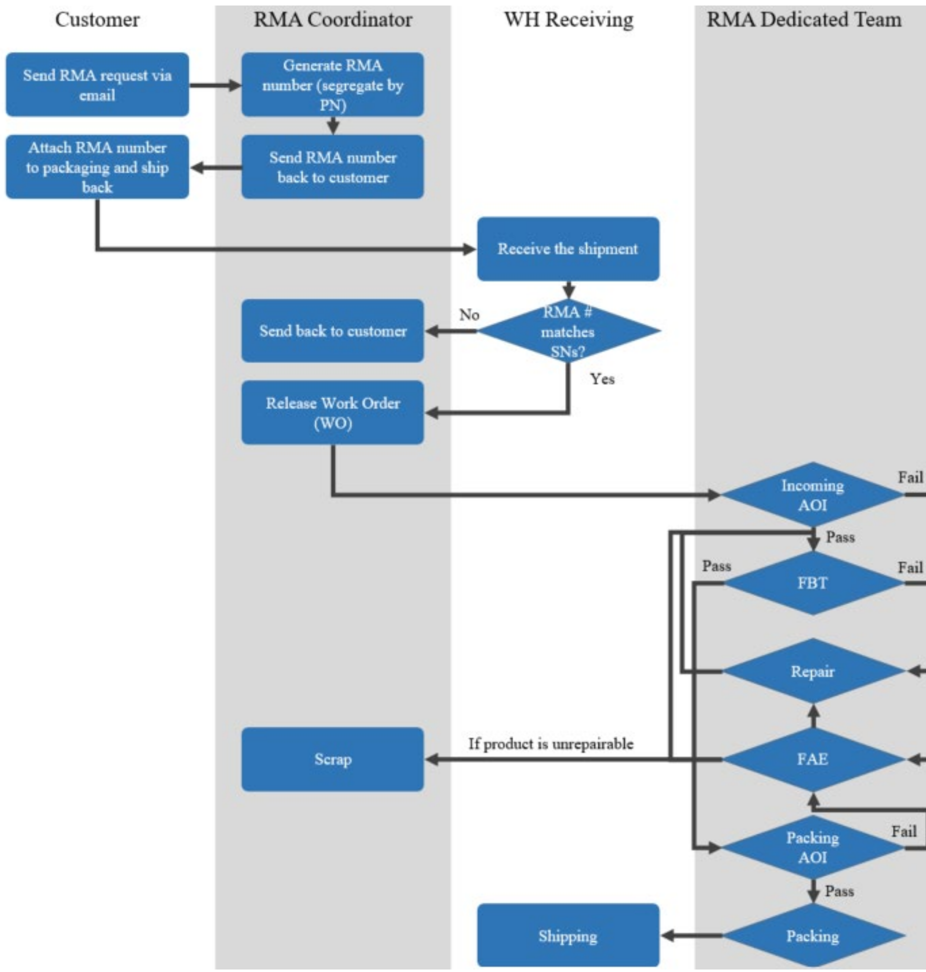


Figure 2. RMA Process for Electric Manufacturing Company in USA

3.2. CIMS

The IT team was requisitioned to help build the CIMS to be compatible with the RMA process as designed. The following various objectives are being considered for the application of computer-integration in the manufacturing system:

- Enhancing the standard of the output and the working environment by standardizing the process and reducing the possibility of human error to happen but automating the iterative tasks or the ones that are hard to be corrected down along the process flow.
- Decreasing the manufacturing lead time. For example, PCBA boards that pass *Packing AOI* automatically move to *Packing* instead of manually updating their status on an Excel sheet.
- Increasing manufacturing's economy of scope.
- Adding flexibility in operations in a way to have a good responsiveness to changes, both internal and external.

The researchers worked with the IT team to ensure the CIMS is matching the workflow on the floor. Figure 3 shows the main screen of CIMS containing 3 main services for RMA: “RMA Request”, “Shop Floor Control”, and “Report”.

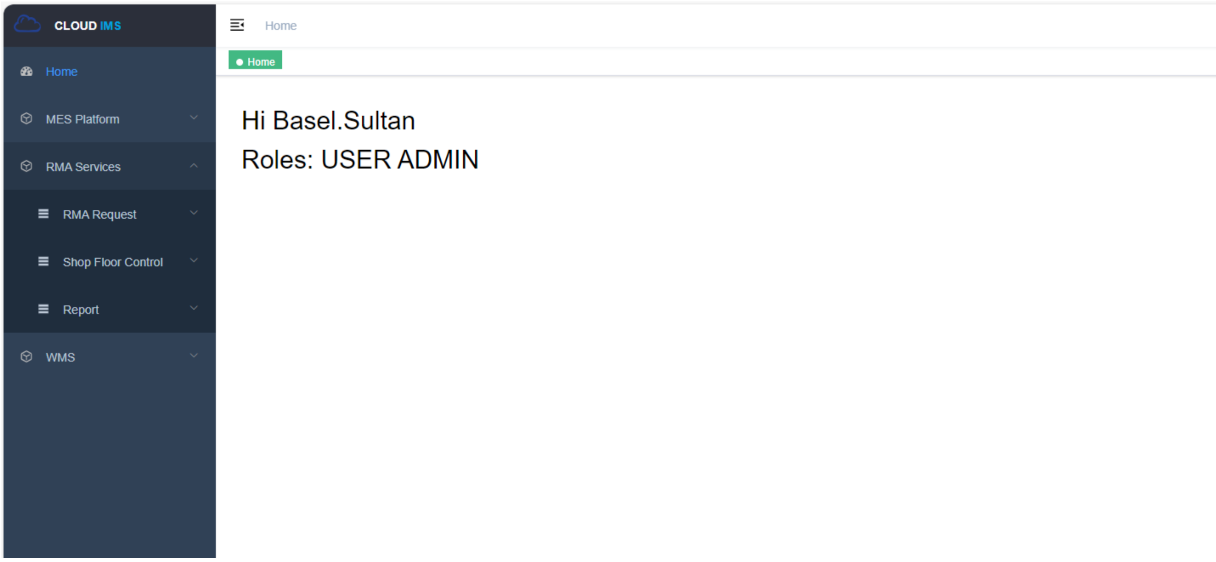


Figure 3. CIMS Main Screen

“RMA Request” is the function that helps the RMA Coordinator in generating an RMA number for a customer request. Under “RMA Request” there are two options: Submit Request and Maintenance Request. Both options are shown in Figure 4. When submitting a request, CIMS is connected to the dataset since no RMA number is generated unless the SN has a shipping date. In other words, the PCBA must have left the facility and subsequently returned to it in order to be eligible for an RMA number. “Maintenance Request” is an option for adjusting any existing RMA number or RMA request. For submitting a request and generating RMA number for the customer, customer name, and original and destination sites are required. The original site is the location where defected PCBAs are coming from. The destination site is the location where the boards must be shipped to after being repaired.

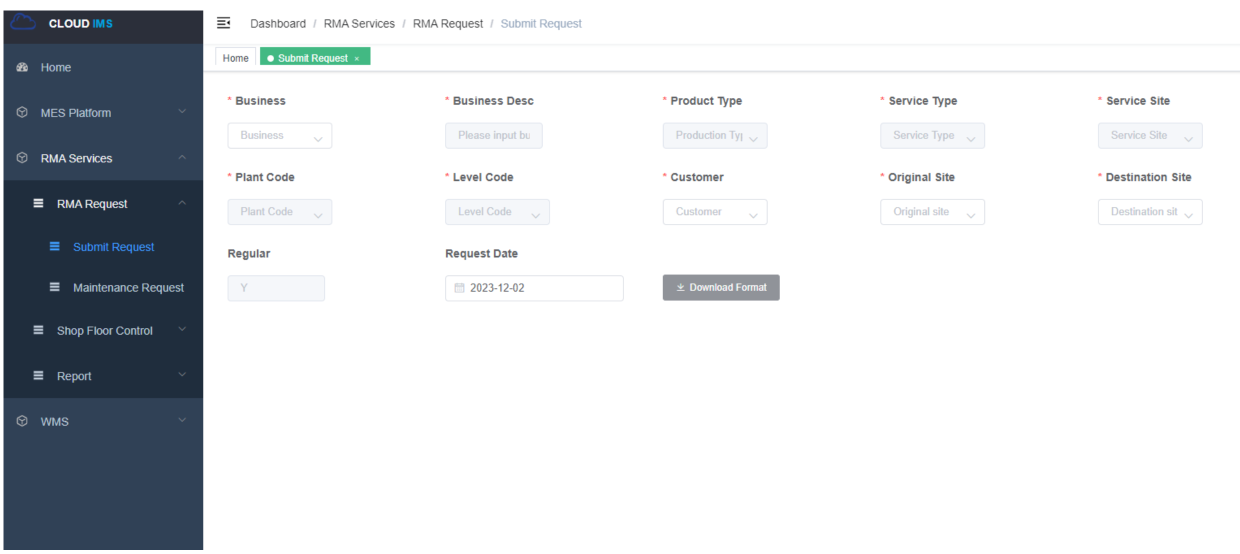


Figure 4. CIMS RMA Request Submission

“Shop Floor Control” option shows all the RMA steps in order. “WH Receiving” is used to scan the SN for the received PCBA. If the PCBA was not previously issued an RMA number, the PCBA will not be received. “Start WO” is an option used by RMA Coordinator to issue a WO. In “Incoming AOI”, which is an automated step, the RMA technician will run the PCBA over an AOI machine where any defects or issues in the assembled printed circuit boards will be inspected and identified. “FAE” is a step that requires manual interaction from the RMA Failure Analysis Engineer to decide the path that a single PCBA has to follow upon its individual case. "Repair" is a manual step and the repair technician is required to generate a repair ticket. Each ticket includes error code, location, symptom, root cause, and repair action. "FBT" is an automated step that goes beyond the traditional electrical tests, which typically focus on checking individual components and circuit connectivity. "Packing AOI" is a similar step to "Incoming AOI" but it is done before packing as a confirmation step. "Packing" is where each group of PCBAs in the same box are given a Box ID. The Box IDs are printed and attached to the appropriate boxes. "Stock In" is a redundant step just to make sure each Box ID is matching the SNs inside that box. "Palletizing" is where each group of boxes on one pallet are given one Pallet ID (Figure 5).

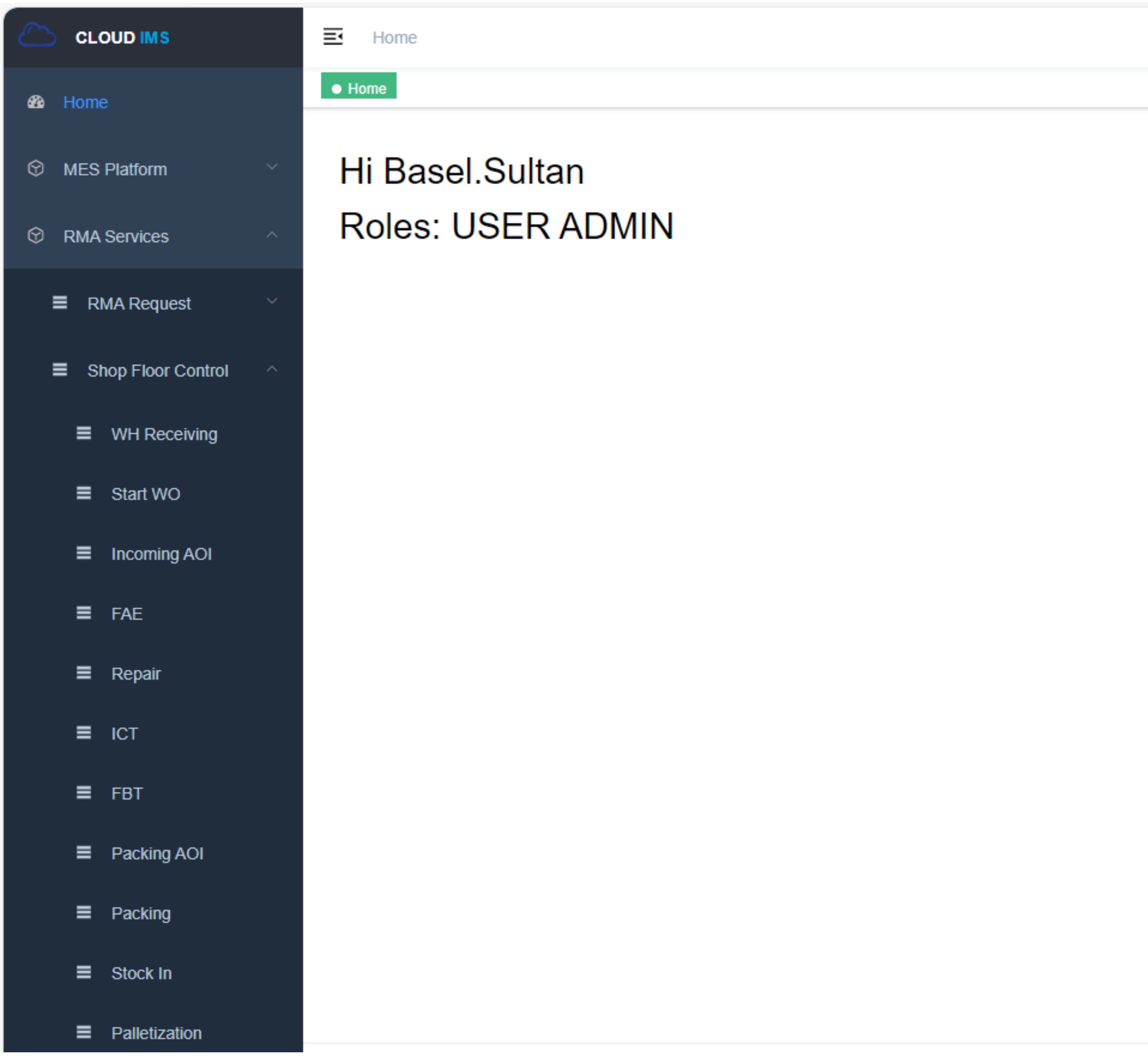


Figure 5. CIMS RMA Shop Floor Control Steps

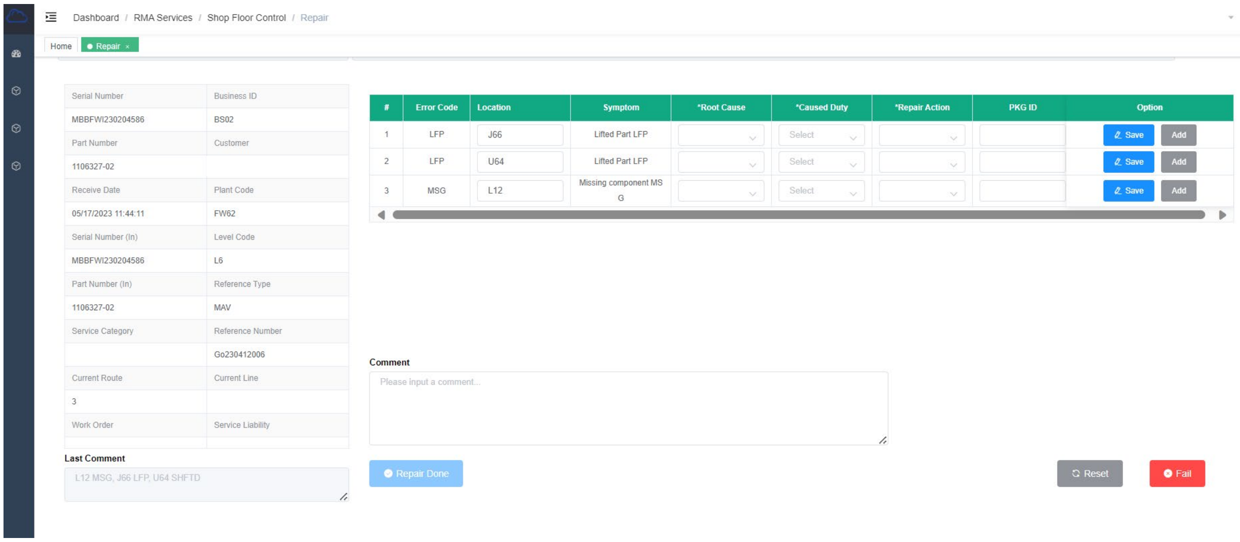
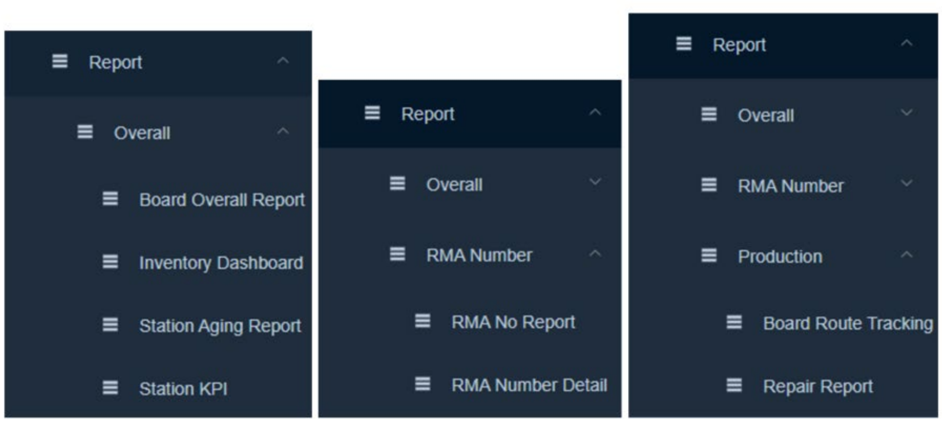


Figure 6. CIMS RMA Repair Station

The third option service is “Report” (Figure 7). This option allows the RMA Coordinator to extract the data they are looking for in an Excel format. “Board Overall Report” helps generating a general report upon the required SN, current station, PN, WO, RMA number, Carton number, etc. “Inventory Dashboard” provides the number of PCBAs in each station at the current moment with a graph showing the operators’ Key Performance Indicators (KPIs). KPIs are metrics used to measure the performance of individual operators or workers on the shop floor. These indicators help assess how well operators are contributing to the overall goals of the manufacturing process. This is essential for identifying areas of improvement, providing feedback, and optimizing workforce productivity. Also, there is another option to track each individual station’s KPI. Figure 7a shows “Report – Overall” options.

“RMA No Report” is used to extract any report needed for any PCBA that received an RMA number even if the PCBA was not physically received by the facility. The last option “Production” (see Figure 7c) is used for data about the board in WIP. The main report that can be extracted from this option is the board route tracking which shows all the steps that a single SN followed and what was the result at each station and who performed it. Also, it shows if there is any AOI, repair or test records. This report is used by the quality and failure analysis engineers to draw some conclusions upon it.



(a) “Report” >”Overall (b) “Report” > “RMA Number” (c) “Report” > “Production”

Figure 8. CIMS Reports

3.3. SAP

With the help of the SAP, the company can combine and automate its core business operations. Two conventional functional boundaries are removed by SAP system applications and solutions. The use of SAP is very helpful because, among other many benefits, it can reduce the use of paper. Enhancements to the business procedures of the organization are also anticipated. For SAP to be efficient, both facilities (manufacturer and customer) must have their SAPs ready (Suryadi et al. 2023). The RMA team held multiple meetings with their IT people and the customer in order to build the SAP network for both facilities and organize the signals flow. Figure 8 explains the SAP locations created for both the manufacturer and the customer and how they are connected to each other.

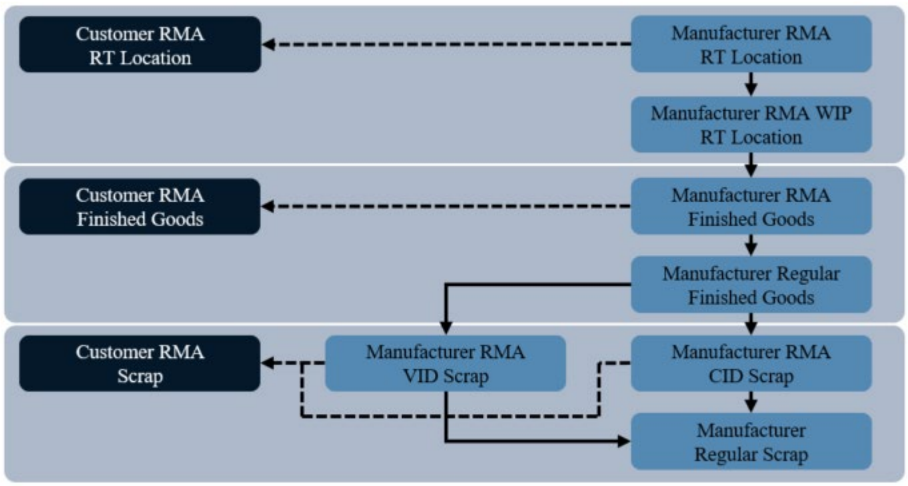


Figure 9. SAP Network

Once the RMA technician receives the PCBA in CIMS in *WH Receiving* station, a signal will be sent to the customer's SAP RT location to inform them that this quantity was received from the customer side to the manufacturer side. When the SN is scanned and ran on *Incoming AOI*, it means this PCBA moved from RMA RT Location to RMA WIP RT Location. If the board got repaired and packed to be shipped back to the customer, a signal will be sent to the customer informing it that this quantity must move from RMA RT Location to RMA Finished Goods location. Eventually, RMA finished goods will be added to the regular finished goods to be shipped back to the customer. But, if the board is scrapped, a signal will be sent to the customer to move the quantity from RMA RT Location to RMA Scrap. But, in the manufacturer side, this is represented by two locations: CID and VID. Eventually, both are added to Regular Scrap Location so they can follow the regular process used for scrapping PCBAs coming from regular production.

3.4. Building Organizational Chart for RMA Team

The management decided to use the hierarchical organizational structure for the RMA team. Hierarchical charts provide a clear visual representation of the chain of command and reporting relationships within an organization. Employees can easily understand who they report to and who reports to them. Also, hierarchical charts clearly define levels of authority and responsibility. This clarity helps in establishing accountability and understanding the scope of decision-making at different levels. It also facilitates effective communication by illustrating the formal lines of communication and reporting.

The manufacturer produces six different products to the customer utilized to create the RMA process as described in this paper. Due to their complexity, having two RMA Coordinators was preferred. Both RMA Coordinators report to one RMA Manager. Some roles are dedicated for each RMA Coordinator and others are shared among both. RMA Coordinators have to organize those resources among them according to the amount of RMA PCBAs from each product. Also, due to some organizational policies, AOI, FBT, Receiving and Packing operators are called RMA Technicians. Since each one of those RMA technicians must have the required skills to do any of the four tasks when needed. Each RMA Coordinator has four RMA Technicians and one FA Engineer. While QE and one RMA Technician are shared among both RMA Coordinators (Figure 9).

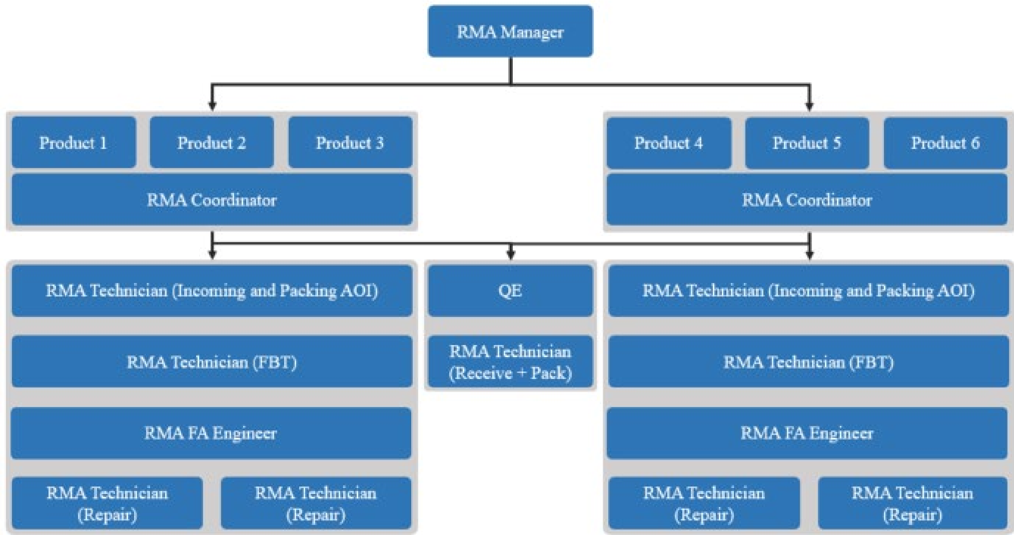


Figure 10. RMA Organizational Chart

3.5. Writing and Releasing SOP

Procedure-level practices with documentation that precisely outline the "who, why, what, where, when, and how" of a task is to be carried out are referred to as "SOP” (Schmidt and Pierce 2016). A crucial component of the entire daily chores or processing activity is the creation and application of SOPs for critical functions. An SOP was written and released for the built RMA process to standardize the process across the company’s teams and to ensure consistency in RMA tasks, reducing variations, and enhancing overall operational efficiency. Quality of the RMA service is also maintained and improved by standardizing the RMA process by providing clear guidelines on how tasks should be executed.

The SOP starts with explaining the purpose of this process and the reason for documenting the process. Scope, references, definitions, responsibilities for each position, materials, equipment, safety and precautions, procedures for each task, management view, and record retention are all mentioned in detail in the SOP.

Two versions of the SOP were created. At the beginning of the planning process, a file called “Long-term SOP” was shared with the team on a shared drive so whenever a team member has an idea or a detail, they are free to add it. Later, another version (the final one) was created by the management depending on the first version that was created by the team. The final version was officially released and signed off by each member mentioned in the SOP besides the management.

4. Results and Discussion

In May 2023, the company initiated the reception of the initial batch of RMA boards from the customer. Managing these returned PCBAs proved challenging for the existing team, as overseeing both the forward and reverse processes became cumbersome using the same team and machinery. Recognizing the complexity, the company engaged researchers to develop a dedicated RMA process.

The newly devised RMA process was integrated into the company's operations and officially implemented on August 16, 2023. Subsequent to the old team's handling of the returned PCBAs, these items were temporarily stored in the warehouse. While some boards underwent testing processes, such as AOI and FBT, they were eventually stockpiled until the formation and readiness of the new team.

The new team opted to address the RMA PCBAs under the assumption that they had not been previously handled by the old team, considering potential adverse effects from extended storage in the warehouse. Employing the "First In, First Out" (FIFO) method, the new team utilized a system of inventory valuation and management where the earliest items added to inventory were prioritized for use.

Table 1 presents the percentage of PCBAs at each station in the process flow, comparing data from both the old and new processes. The findings reveal that, under the old process, no products reached the end of the process; however, after the implementation of the new process, all products were successfully packed and shipped back to the customer.

Figure 10 illustrates the cycle time required for each individual PCBA to traverse the process. The observed decline in cycle time can be attributed to the learning curve, as the team acclimates to the work over time. Additionally, the new process initially shared resources with the forward process until dedicated resources were established.

Table 1. Old and New Process Compression

	Incoming AOI	FBT	Repair	Packing AOI	Packing
Old Process CT (days)	100%	10%	1%	1%	0%
New Process CT (days)	100%	100%	100%	100%	100%

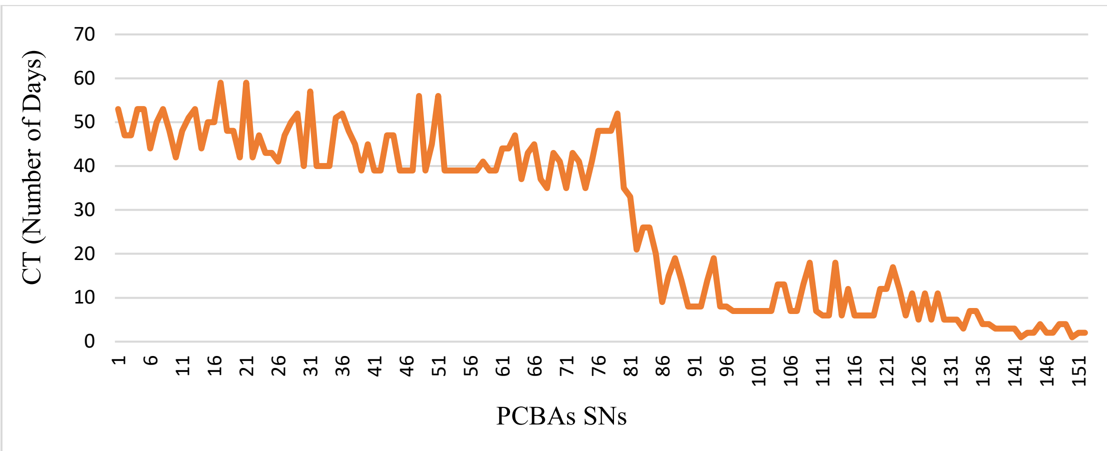


Figure 11. New Process PCBA CT (Days)

5. Conclusions

An improved and automated RMA process for an electronic manufacturing company in the USA was developed and integrated into the business operations. The CIMS was programmed and developed to match the physical RMA process. SAP was created to match the customer's SAP network. Later, CIMS was attached to SAP to ensure any receiving in or shipping out of the system is recorded financially via SAP. The suitable organizational chart was built and operators are assigned to each position. The RMA SOP was officially released and the new team got trained upon it. The process was implemented on real life and showed its effectiveness.

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Biographies

Basel Sultan is an Industrial and Systems Engineering MS degree student at The State University of New York at Binghamton. He is a graduate research project assistant conducting his work as an RMA Coordinator at Foxconn Industrial Internet Company. Basel earned his BS degree in Industrial Engineering from Sultan Qaboos University (2022), including a semester taken from Marmara University through an exchange program (Spring 2019). Basel has an accumulated three years of a proven track record of experience in different companies and organizations. Basel's research interests include supply chains, optimization, and design of experiments, project management, and not-for-profit operations. Basel is a member of the Palestinian Engineers Association.

Daryl Santos is a State University of New York (SUNY) Distinguished Service Professor at Binghamton University. He has received the SUNY Chancellor's Award for Teaching and the SUNY Chancellor's Award for Scholarship and Creative Activities. Daryl holds a BS degree in Operations Research and Industrial Engineering from Cornell University (1987), an MS degree in Industrial Engineering from the University of Houston (1990), and a PhD degree in Industrial Engineering from the University of Houston (1993). He also holds a Lean Six Sigma Black Belt from Dartmouth College's Thayer School of Engineering. Daryl is the founding managing editor of the Industrial and Systems Engineering Review (ISER) Journal.

Thomas Byrnes is the PMO Manager for Foxconn Industrial Internet in Mount Pleasant, Wisconsin. Thomas is a native of New York State. Thomas studied his undergraduate at Marist College in Poughkeepsie, New York, before moving to China to study Mandarin Chinese, where he lived from 2013 to 2019.