IMPLEMENT DMAIC AND ERP SYSTEM TO IMPROVE PRODUCTIVITY AND QUALITY IN MECHANICAL COMPANIES: A CASE STUDY

Nguyen Minh Thu, Thai Thanh Sang, Truong Hoang Khoi, Du Ngoc Bao Tran, Nguyen Thi Anh Vien, Ly Duc Minh*

Faculty of Commerce, Van Lang University

*Email: *minh.ld@vlu.edu.vn*

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ABSTRACT

Six Sigma is a popular method in process improvement activities and production processes to improve productivity and product quality. In the Six Sigma approach, using the Define - Measure - Analyze - Improve - Control (DMAIC) cycle to review and examine abnormalities in the operational process and take corrective action to reduce bottlenecks to enhance productivity, stable product quality, and make the production cycle tightly connected. In this study, the monthly delivery delay rate was about 6.28% after applying the DMAIC cycle in the analysis of the current state of the machining process and the 5 why analysis tools in the root cause analysis of delay arising after that integrating two Enterprise Resource Planning (ERP) modules for product quality control and order information control in the processing line with Radio Frequency Identification (RFID) function to control orders. The result achieved after the improvement is to reduce the rate of a delivery delay from 6.28% to 0.02% month by month.

Keywords: RFID, ERP, DMAIC, Continuous improvement, Lean Six Sigma, 5 Why.

1. INTRODUCTION

The development has been outstanding, along with the development of digital technology and especially information technology applied in manufacturing factories. Internet of Things (IoT) technology creates a platform for connecting digital devices without contact and transmitting data through signal cables. The development of this technology has brought great benefits to the manufacturing outsourcing industry and the mechanical processing industry in particular. In the context of an increasingly competitive economy among manufacturing industries, mechanical companies compete with each other in terms of quality as well as customer market shares. Any mechanical processing company that fails to improve product quality, machining processes, and utility machine tools to improve productivity will become stuck and risk losing customers to competitors. Mechanical processing factories often organize processing in separate stages, each stage will process one or more parts on the product body and finally, the overall inspection stage for all dimensions to be processed. Mechanical items with appearance inspection based on client specifications, the processing steps are linked with each other via the ERP system of production management on each stage (daily report system), see Figure 1 for a flowchart of the daily reporting system. A barcode reader and a tablet computer with an ERP software system for order tracking are installed. Outsourcing orders with barcodes, content related to orders according to customer requirements about product lines, delivery time and order information at the mechanical processing company and the date of starting to issue orders to the expected date of shipment and each stage is made a corresponding barcode.

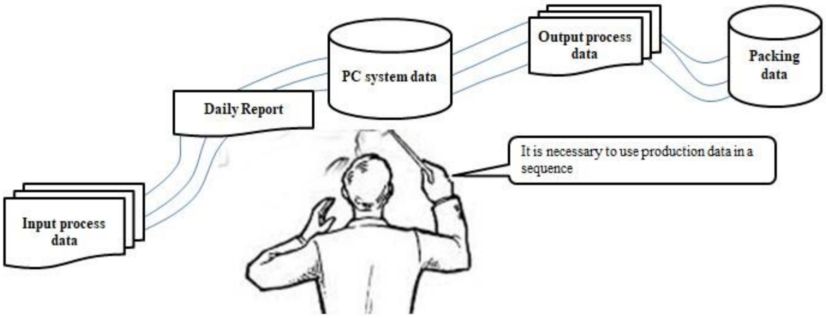


Figure 1. The flowchart of the daily report system

In a production environment, there is data related to outsourcing orders and much different data information supporting the most efficient production environment data on order management on the line. At each stage called WIP (work in process), the ERP system on order dimensions and data from the ERP system manages the tracking conditions for specific stages of heat, powder coating carbone, molybdenum powder and ERP system of abnormal quantity control on each. Figure 2 shows the manufacturing data system; the process data is deployed using specialized ERP systems, but the ERP systems simply control the quantity by scanning barcodes on orders and the system accesses the production data system to get order information about item name and quantity as well as processing time leaving data for each job. However, no system or research has shown that the user control data product quality from the ERP system to employee. The system of measuring actual product dimensions deployed at the stage is designed based on product dimensions, tolerances, location of each processing stage and processing sequence [1], so the gas processing organization needs to quickly and flexibly create the fastest and most profitable option to pursue a competitive environment [2], using a combination of real-size data from the measuring system at each stage [3] to feed into the system ERP manages orders on each line, then compares it with the data in the order management system, updates the data at the order management system in terms of quantity if damaged goods arise in the processing line. Production planning department personnel timely update real-time information about the actual output of each processing order [4] at each stage, which prompts the issuance of additional orders to prevent delays in orders, products to customers and improve customer satisfaction, as well as enhance competitive advantages over rival companies in terms of delivery time and product quality.

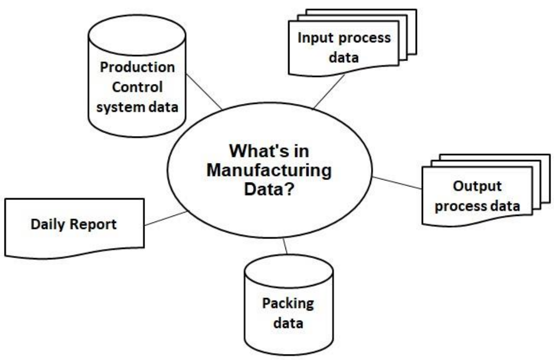


Figure 2. The manufacturing data system

This study focuses on using RFID to control orders at each processing line by accurately scanning order barcodes, connecting information from RFID to opening the dimensioning system at the corresponding stage. The response is to measure the product dimensions after completion and record the results without noticing the results that are not in the customer's required specifications or the processing requirements at each stage, eliminating damaged goods, and updating the product size to be entered into the order management system continuously overtime at each stage, so that the order management staff can identify the details of the order quantity and make a decision to issue an order. When exporting goods, measurement data at each stage is shown on a screen in the processing line, where personnel can check the status of each order in terms of quality and quantity. The research paper is organized according to the structure; part 2 presents a literature view about relation research; part 3 introduces raw material about the theoretical basis of Lean Six Sigma related to the DMAIC cycle and hypothesis testing and a methodology applied to the case study. For mechanical plants, presented in parts 4 and 5, the results and discussions related to the research content are presented, section 5 shows the conclusions about the research topic and future research directions, and the last show related content references.

2. BACKGROUNDS AND RELATED WORK

Continuous improvement activities applying the DMAIC (Define-Measure-Analysis-Improve-Control) cycle make a significant contribution to making the improvement operations clear, smooth, and highly efficient [5]. Improving the process involves real-time tracking in the production process by applying RFID technology that combines ERP software modules in different functions and applications [2] into a unified management unit. Database, identifying and classifying strengths and weaknesses when using RFID is significant when deploying RFID into use the relationship between benefits of use and expected benefits have not been clearly partitioned, the application of RFID into business processes is now bringing three benefits such as cost savings, supply chain visibility, new process creation, and determining the size and scope of RFID applications. The point of RFID technology is that it can connect data with systems such as global positioning or product life cycle management systems [6].

2.1. Enterprise Resource Planning (ERP)

ERP is a multi-functional management software that can collect, store and analyze data in business operations from product planning [2]. Cost of production or service provision, marketing, delivery, and payment.

ERP is the bridge that provides information and integrates functions most effectively, see Figure 3, resulting in increased labour productivity, time and cost savings, increased revenue and profit for the company when applying ERP.

Figure 3. ERP inspection system operation flow

Track products by lot number, quantity, and product name through barcode scanning and save barcode information on outsourcing orders into the SQL system and order management staff check the information on the system SQL but cannot directly check the status of processed products meeting customer requirements at each stage in real-time, so it is not possible to make a decision to make up the order before a delay arises products that make customers unsatisfied.

2.2. Radio Frequency Identification (RFID)

RFID collects data into the server system and processes the data, serving monitoring, statistics, and control in the system, see Figure 4.

Figure 4. RFID operation flow

Information in the product supply chain is displayed clearly, RFID supports saving a lot of data in the business, and the business can use it in business activities.

2.3. Manufacturing process management in the RFID and ERP

Order and product information circulate on each processing through stages, and data information on orders is done by swiping barcodes on orders transmitting order data to SQL network system, see Figure 5.

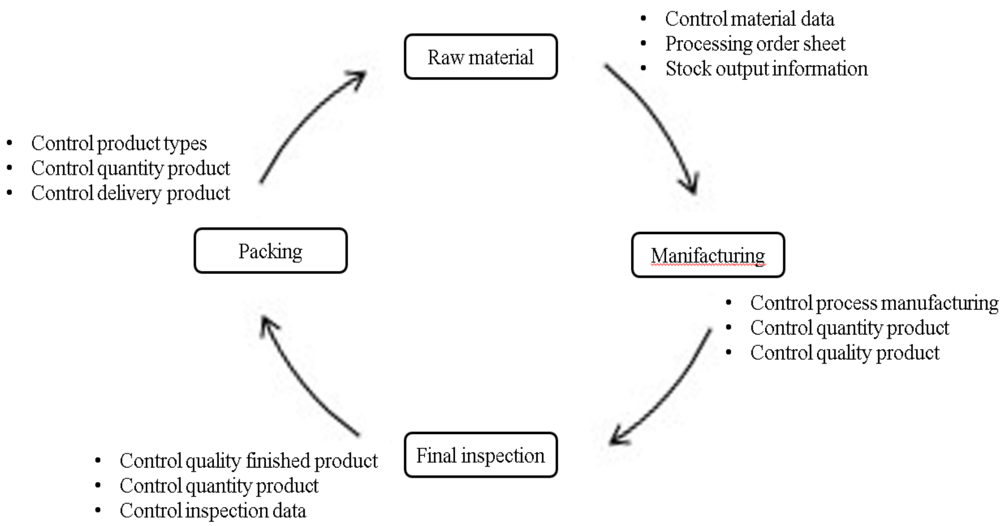


Figure 5. Product data information flow

The flow of order information at each processing line and the SQL system is done on a simple data source from material information control, machining line control, and shipment inspection.

2.4. Related work

Söderberg *et al.* proposed to use the Digital Twin method to perform a combination of quality control and simulation into an overall system that adjusts to optimize production and form a system capable of individual production, real-time monitoring, and optimization of the product's machining process to improve flexibility in product processing [1].

Ding *et al.* presented a unified RFID-SMS method from the raw material supplier to the manufacturing company environment and the transporters in a unified way to collect real-time data about production results and the flow of products moving in the chain. Next, managers concerned individuals use this real-time collected data to analyze the process scene and take immediate improvement action [2].

Kwon *et al.* proposed using the 'Procedure Tree' (PT) method to manage data collected in real-time from RFID technology to collect large amounts of data and connect RFID to the system platform. EIS, along with that, collects data from the Enterprise Resource Planning (ERP) database and analyzes data in real-time at each stage in the processing system, such as control of processed goods on the line or inventory [3].

Chongwatpol & Sharda applied RFID technology to collect real-time data of processed products on the line, inventory products, finished products, and raw materials and data linkage obtained into the visibility-based scheduling (VBS) system, then using this data to analyze and adjust the production plan accordingly in real-time, the results show that the data collected from the application RFID technology responds well in real-time, and the results of the analysis are displayed on the table in an intuitive way [4].

Lizarelli & Toledo used the status assessment activity based on the field records related to continuous improvement activities and investigated the performance based on the results of the assessment documents, the results show that there are still some limitations in continuous improvement activities such as the process of implementing continuous improvement is unclear, the activities to encourage improvement are not satisfactory, despite the existing difficulties, the implementation of perfecting the cycle again, and continuous improvement [7].

Castro & Junior interviewed 24 experts in the outsourcing organization, including mechanical technicians, electrical technicians, and area leaders. The contents of the interviews were as follows: reduction of waste, the training of the workforce, and the translation of corporate goals into intangible goals for the plant. The results show that the critical points in the implementation of continuous improvement are employee satisfaction in the organization, changing the execution process, and not wanting to change what is being done to choose the suitable explainer to solve the above problem [8].

Jevgeni & Roman combined tools such as Six Sigma DMAIC, FMEA, TOC, FC, swim-line diagrams into analyzing abnormal errors in the process of daily survey implementation through improvement activities. Continuous progress in finding the root cause and suggesting improvement activities on time [9].

Kregel *et al.* introduced combining process mining with Lean Six Sigma tools by surveying of Six Sigma professionals, a technical experiment, and a multi-case study in a company to explore extensive data processing capabilities in manufacturing plants [10].

Mast & Lokkerbol explored in-depth analysis of the DMAIC cycle according to domain specificity of methods, problem structure, generic problem-solving tasks, diagnostic problem-solving, and remedial problem solving. The results show that quantitatively robust data systems support the DMAIC cycle; on the other hand, the DMAIC cycle still has methodical generality limitations. The underlying cause-finding methodology and weak data aggregation techniques. Therefore, those who use the DMAIC cycle should know the above and pay attention [11].

Sin *et al.* surveyed of experts on the relationship between the implementation of Six Sigma operations and the performance of the operation process is closely related, the successful Six Sigma project, the products the company's operations also grew strongly [12].

Pugna *et al.* proposed the application of the Lean Six Sigma tool to implement quality improvement activities in the product processing process in order to improve product quality, eliminate waste and improve productivity, as well as enhance advantages compete for manufacturing enterprises by methods such as applying the DMAIC cycle (D-Define, M-Measure, A-Analyze, I-Improve, C-Control) to the current stages and processes that need to be implemented. Improve and cycle DMADV (D-Define, M-Measure, A-Analyze, D-Design, V-Verify) into the product design process [13].

Rohin Titmarsh *et al.* applied the Six Sigma cycle in the industry 4.0 manufacturing environment based on information and communication technology to the Lean Six Sigma relationship in the DMAIC cycle to improve the machining process [14].

Costa *et al.* used the DMAIC cycle to control the machining process identify and qualitatively measure the factors affecting the process to eliminate fluctuations in the process, and not create anomalies or changes in machining [15].

Wei *et al.* introduced the study to focus on the element of RFID assimilation into different systems being deployed and used in the same company, based on the TOE framework and based on the experimental results, the problems related to important factors affecting the implementation of RFID technology connectivity are IT infrastructure, managerial capability, absorptive capacity, and environmental uncertainty significant [17].

Ji Fang *et al.* introduced a technology called Gateway Operating System (GOS) manages agents that allow RFID to connect with other systems through Plugs to ensure the flexibility and extensibility of the GOS, linking and exchanging information with other systems through the function. XML (Extensible Markup Language), a lightweight GOS system is easy to use in a production environment and low cost [18].

Ramayah *et al.* used the Innovation Diffusion Theory (IDT) to train and improve the acceptance of technological innovation for the country, using the partial approach. Least-squares to analyze data obtained from the production of small and medium-sized enterprises in the country, the analysis results show that technology makes enterprises change processes and improve competitiveness compared to other enterprises with opponents [19].

Ngai *et al.* analyzed the implementation factors of RFID implementation in the production environment on eight aspects of the management system, namely, vendor selection, organizational motivation, cost/benefit evaluation, top management support, user involvement, the extent of progress supervision, staff competence and training, and policy, structure, and operating process compatibility in terms of the challenges faced by the system when implementing the system [20].

3. RAW MATERIAL AND METHODOLOGY

3.1. Notation for Parameters

X: Random variable

W: Reject domain

α: Level of significances

z_0, t_{qs}, x_0^2: Test statistices

s^2: Standards deviation

μ, σ^2: Expected

$\overline{X}$: Unbiased estimate

H_0: Null hypothesis

H_1: Alternative hypothesis

$t_{\alpha/2}^{n+m-2}$: Loo up value from student distribution table

$x_{\alpha,n-1}^2$: Look up value from normal distribution table

3.2. Hypothesis Mathematical Model

Definition 1: Hypothesis is testing on the mean, variance known (z-test), suppose that we wish to test the hypothesis [21]:

$$H_0: \mu = \mu_0, H_0: \mu \neq \mu_0 \tag{1}$$

Where μ_0 is a specified constant. It is usually more convenient to standardize to the sample mean and use a test statistic based on the standards normal distribution. That is the best procedure for $H_0: \mu = \mu_0$ uses the test statistic:

$$z_0 = \frac{\bar{X} - \mu_0}{\sigma / \sqrt{n}} \tag{2}$$

And two-sided test reject domain:

$$W = (-\infty; -u\alpha/_2) \cup (u\alpha/_2; +\infty) \tag{3}$$

One right side test reject domain:

$$W = (u_\alpha; +\infty) \tag{4}$$

One left side test reject domain:

$$W = (-\infty; -u_\alpha) \tag{5}$$

Definition 2: Test on the variance and standards deviation of a normal distribution suppose that we wish to test the hypothesis that the variance of a normal population σ^2 equal σ is equal specified value, say σ_0^2, or equivalently that the standard deviation σ is equal to σ_0. Let $X_1, X_2, \dots X_n$ be a random sample of n observations from this population to test [22].

$$H_0: \sigma^2 = \sigma_0^2, H_1: \sigma^2 \neq \sigma_0^2 \tag{6}$$

We will use the test statistic:

$$x_0^2 = \frac{(n-1)S^2}{\sigma_0^2} \tag{7}$$

Two side test reject domains:

$$W = (0; x_{1-\alpha,n-1}^2) \cup (x_{\frac{\alpha}{2},n-1}^2; +\infty) \tag{8}$$

Right side test reject domain:

$$W = (x_{\alpha,n-1}^2; +\infty) \tag{9}$$

Left side test reject domain:

$$W = (0; x_{1-\alpha,n-1}^2) \tag{10}$$

3.3. DMAIC Methodology

At a production line, mechanical components go through stages. The order management department receives product processing orders from customers about product types, quantities, and delivery terms, then issue processing orders and sends them to relevant departments. The warehouse department receives the processing order and uses the barcode scanner to record the order information, export the raw materials to the SQL system, and do the same for the outsourcing production management department at each stage. Also, scan the barcode on the processing order to record the information at the stage of the order being processed and call the measuring program at the corresponding stage to check the product quality; at the delivery inspection stage also scan the code. The line on the order and call the measuring program on the corresponding system according to the basic order information, measure the product quality according to customer requirements, and finally send the finished product to the packaging and printing stage. Packaging products see Figure 6 on flow chart of mechanical product machining process at a mechanical factory.

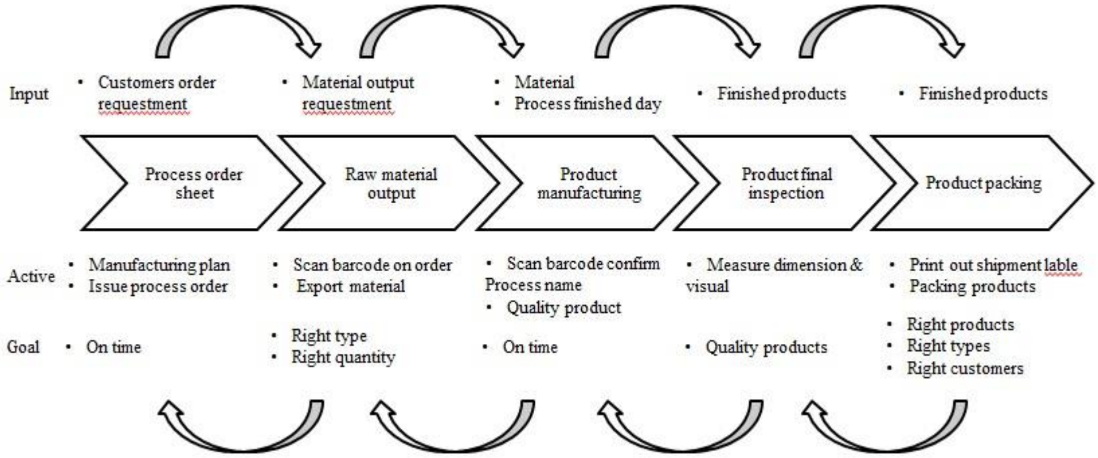


Figure 6. Mechanical products manufacturing flow chart

3.3.1. Define phase

As standard, the companies to customer's allowable delay ratio of 6 orders per year, by randomly testing 100 samples, the average value of order delay is 6.4 orders, with significance level 0.05, it can be assumed that the order delay rate is either substandard or substandard, given that the order delay rate is a normally distributed random variable with a standard deviation of 2 mm apply constraints (1-5) to validate the problem.

Conforming to the hypothesis of the parametric test of Two-sided Test:

$$H_0: \mu = 6.4, H_1: \mu \neq 6.4$$

With significance level α = 0.05, look up the normal distribution table: $u_{0.025} = 1.96$. Rejection domain: W = (- ∞; -1.96) ∪ (1.96; +). With $\bar{X} = 6.4$, the value of the statistical criterion: $u_{qs} = \frac{(6.4-6.0)}{2*\sqrt{100}} = 2 \in W$. Rejecting H_0 , the order delay rate does not meet the standard. In conclusion, the control of orders during operation is not satisfactory, cannot control the amount of production according to the required processing time at each line, each stage.

Using the time series chart in Minitab 18.0 software, analyse the rate of order delay of the precision mechanical product line at the mechanical component processing firm from January 2020 to June 2020. The results show that the late generation of orders always tends to increase and fluctuates between months of the year. In fact, in Jan-2020, the order delay rate was 7.04%, in April 2020 alone, there was a sudden increase of 7.12%, although in June 2020, the late order rate decreased but remained at the same level 6.83%. See figure 7 shows the time series chart of the rate of happened delay of orders.

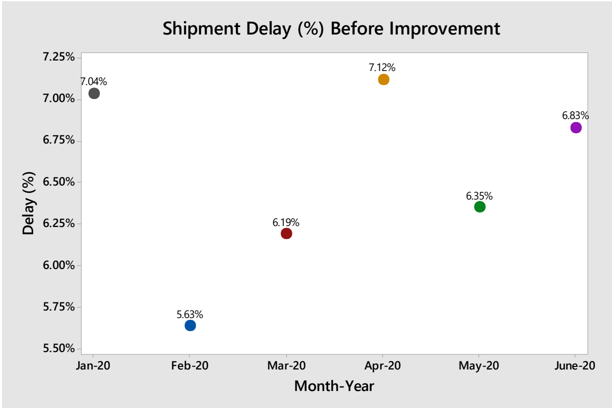


Figure 7. Time series chart the rate of happened delay of orders

The rate of the late generation of orders has the following speculated causes:

(1) Order verification from the time the processing order is issued, the order is transferred to the production department, and then to the packaging line is inconsistent.

(2) Only control order information but ignore the actual determination of product quality on each order. Receive information that the order has been completed, but the product is not of the quality required by the customer.

(3) Tracking order status depends on the employee's QR Code swiping on order. It is complicated and uncontrollable to control human behavior. There is a delay in the delivery of orders at the customer's request.

(4) Information on product quality at each production stage is inconsistent in terms of quality. In the pre-processing stage, the size is not satisfactory, but the product is still transferred to the following processing stage and cannot control the product size that does not meet the customer's requirements. Until the final inspection stage to re-check and detect damaged goods. As a result, there is no time to make up for damaged products.

Objectives should be set to improve and overcome the above abnormalities:

(1) Real-time control of processing orders by QR Code and RFID barcode systems, monitoring the status of order quantity at each stage in real-time.

(2) Connecting the actual size measurement results on the measuring system at each processing line to the order control system, monitoring the product quality status at each processing line, and tracking the quantity required by the customer at each processing line in real-time.

3.3.2. Measure phase

Using the Pareto charting function in Minitab 18.0 software to analye errors arising from late orders from January 2020 to June 2020, the main reason is (1) defective products arising in the production process accounted for 51.6% (2) local overload at the processing stage accounts for 33.2%. (3) other errors accounted for 15.2%. Figure 8 shows the reason for the delay in the order.

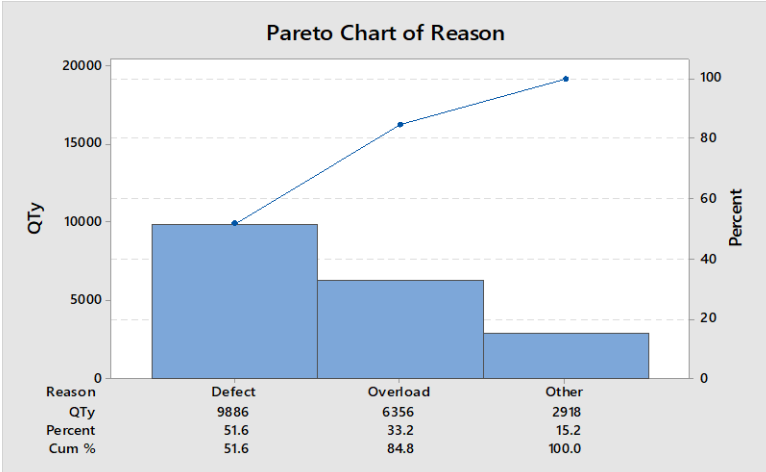


Figure 8. Shows the reason for the delay in order.

Order management employees must identify information based on the number of items accomplished on each order in real-time to plan for making timely choices on up-processing orders or contacting customers when an order fails to deliver goods on time. As a result, upon identifying the reasons for order delay using the fishbone diagram to thoroughly analyse it and recognizing that the technique of order control is simply by barcode (see Figure 9 analytical fishbone chart), the reason for the order delay, we only know the information about the order passing by the time of each step, but we cannot control the genuine quality of the product in real-time at each stage. The reason is that the processing staff swipes the barcode to identify the processing stage, the information is transferred to the SQL system, the order management staff controls the information on the SQL system.

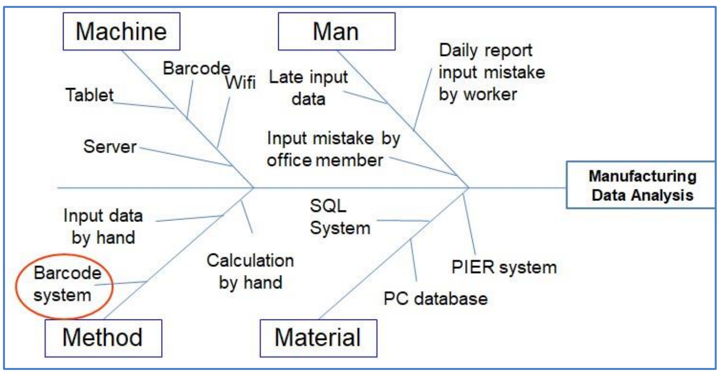


Figure 9. Analytical fishbones chart the reason for the delay of the order

In the instance of order information control number 123456, the amount to be processed is two goods. Figure 10 flowchart to control processing orders by barcode, employees at each processing stage swipe barcode, Figure 11 display control processing sheet by barcode, and barcode information is uploaded to SQL system as order number 123456, quantity is 2 finished. Processing, the order management staff plans to ship the goods to the customer based on the processing completion information on the SQL system, but order number 123456 only has 1 product, 1 product has been generated, so there is no shipment, causing delays in the delivery of the goods promised to the customer by the order management department.

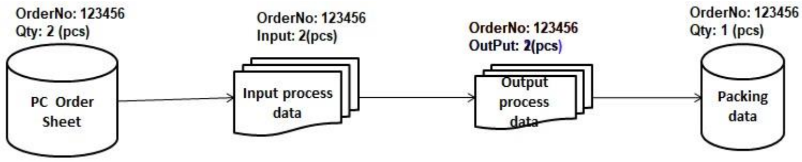


Figure 10. Flowchart to control processing orders by barcode.

In another case, to complete the processing KPI within the day, the processing staff used the barcode scanning system to swipe all the orders simultaneously even though the product has not been processed to report the actual processing performance on the product. In the SQL system, the querying process did not process the order in time, but it did not inform the order management department but just swiped the bar to determine the information on the SQL system that the processing was completed.

Figure 11. Control processing sheet by barcode

3.3.3. Analysis phase

The 5 why analysis flowchart from the Toyota manufacturing system may be used to identify the root cause of a frequent problem, see Figure 12 for an example of the 5 why analysis flowchart from the Toyota manufacturing system. To determine the source of the problem, ask the analysis inquiry to the third why in the area of the reason why happened, and to determine the cause connected to the system, analyze the fifth why in the what is underlying frame cause.

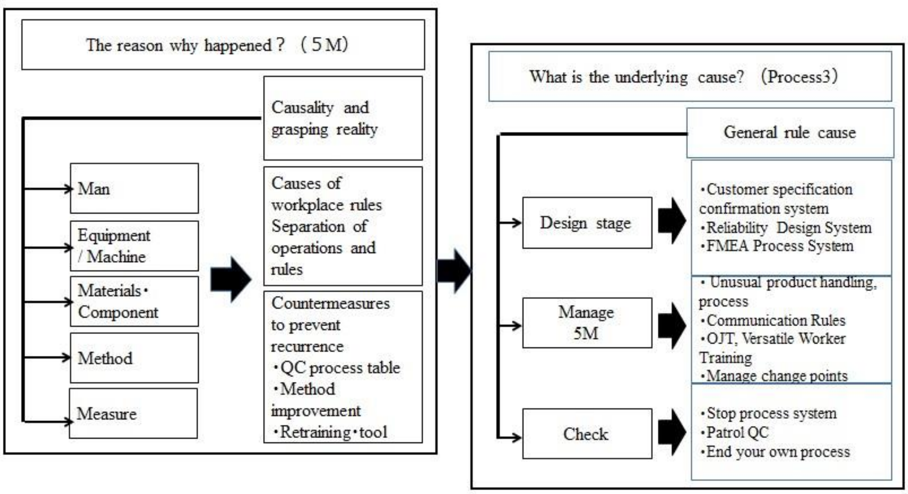
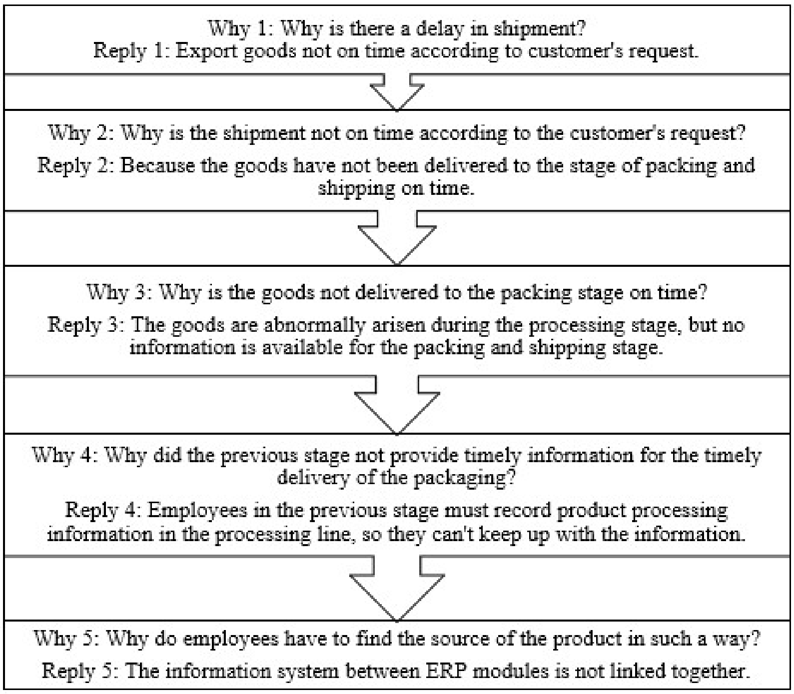


Figure 12. 5 whys analysis flowchart

The 5 why analysis technique has been developed and widely applied in analytical activities to find the root cause problem. Applied in analysis to find the cause of delay in delivery in mechanical processing plants, see Figure 1 for the analysis content to find the root cause of delay in delivery, the results of the 5th why and realize the problem point is that the communication as well as the information connection between the ERP modules in the outsourcing transfer is not linked. The border control system in the product information control chain, ERP system on product quality control. These two systems have not established a link, so the production management department cannot control the actual quality and quantity of products achieved in each processing line, leading to one-way information and product performance to meet the requirement one way.

Table 1. 5 why content analysis late delivery



At the end of the working shift, the employee must check the results on each stage about the content of the actual measurement results of each order and check the quantity of each order at each stage and summarize the report to send to the management office order handling. Even though an ERP system for order information management by barcode system and product quality control by quality control ERP system is being implemented.

3.3.4. Improve phase

Actual product dimension measurement data from the ERP system, as well as each order information after scanning the barcode on the processing sheet, processing plan information, shipping information, and customer controls, will all be kept on the SQL system. Realizing the problem point and making an improvement is to connect the measurement data from the quality control ERP system to the order control system combined with the RFID system to manage in real-time each order at each work on the achievement of standard-sized products from the quality ERP system, then transmits data to the order management system to compare and control the number of goods reached each stage. Figure 13 measuring system ERP quality control and order control system are integrated on each processing line.

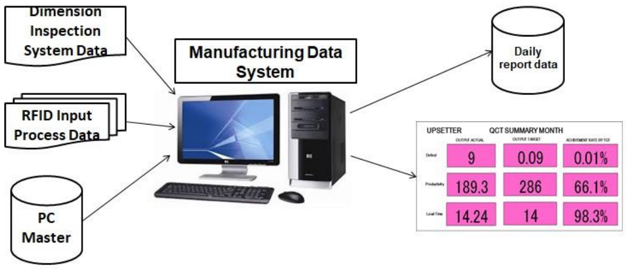


Figure 13. Integrate 2 ERP systems for order control and quality control.

Get data from the production control system (pc) linked to the data of each stage through the RFID system combined with the data of the product size check system, Figure 14 show Integrate 2 ERP systems for order control and quality control in process, all linked together on the SQL system in the system production data, the results after analysis will output data over time through analytical charts and display the data of each order in real-time on the screen.

Figure 14. Integrate 2 ERP systems for order control and quality control.

3.3.5. Control phase

Real-time monitoring at the machining line aims to let employees know the individual's own work results in real-time and even during the working process, so the real measurement data for each Order processing combined with the information of each order at each processing line is shown on the screen and placed at the processing line, Figure 15 control screen monitors product information in real-time at the processing line after combined product performance put quality processing on each order.

Figure 15. Control screen monitors product information in real-time.

Order number 123456 was required to be processed with 10 products, but at the grinding stage, 2 products, were damaged and immediately the order manager became aware of the number of processing requests. Missing 2 products and immediately issued a processing order to make up for the shipment.

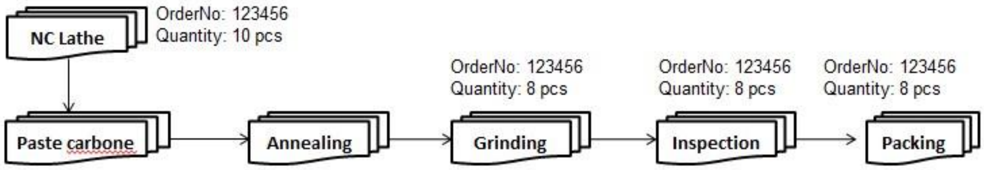


Figure 16. Real-time tracking of processing orders

4. RESULTS AND DISCUSSION

Real-time control of orders in a manufacturing environment is significant. Combining actual dimensioning data on each product on each machining line and combining it with a single control system has made tracking of outsourcing production accurate and straightforward in real-time, deciding to control shipment by term clear and accurate.

4.1. Results

Tracking the results of shipment delay data analysis from July 2020 to December 2020, shows that control over time significantly reduces and improves customer satisfaction from order delay July 2020 is 6.28% and the late delivery rate decreases over time, the result to December 2020 is 0.02%. Figure 17 depicts the actual monitoring of shipping delays between July 2020 and December 2020. The delay is that the processing order is too difficult, requiring high processing technology and high skills to eliminate the error caused by the generation of defective products and the error caused by the delaying process that causes the delay of the order.

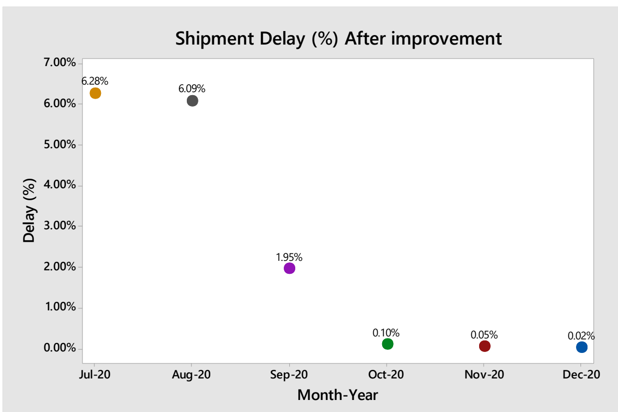


Figure 17. Actual tracking of shipment delay from July 2020 to December 2020

Sub-section heads secondary headings or second-level headings should be bold-faced, 11-point in upper and lower case as shown. For subsection heads, a word like "*the*" or "*a*" is not capitalized unless it is the first word of the header. Choose *JICT-Heading 2* from the style.

After improving integrating 2 ERP systems for quality control and order control on the processing line, randomly taking 20 samples about the delayed shipment to get the standards deviation $S'^2 = 0.0153$, the dispersion does not differ by more than 0.01. At significance level of 5%, let's check whether the improved integration 2 ERP systems are successful or not. The shipment delay is a random variable with a normal distribution. Apply constraints (6-8) to verify the problems.

Null hypothesis: $H_0: \sigma^2 = 0.01;\ H_1: \sigma^2 > 0.01$. With significance level $\alpha = 0.05$, and degress of freedom 19, look up the Chi-square distribution table: $x^2_{0.05;19} = 30.144$. Reject domain: $W = (30.144; +\infty)$. With $s'^2 = 0.015(1^2)$, the value of the statistical: $x_{qs} = \frac{(19-1)\times 0.0153}{0.01} = 29.07 \notin W$. Accept hypothesis H_0. After integrating two ERP systems for quality control and order control on the processing line, the results are as expected.

4.2. Discussion

Integrating two ERP systems for quality control and order control on the processing line to monitor the progress of outsourcing orders in real-time on each line, each step to aid in inventory control on the line precise, assisting in making precise machining instruction selections and orders. The benefits of system integration are significant, but they also necessitate a high level of agreement from the operator; thus, the middle leadership role must make efforts to explain the obvious role to the operator role, the purpose of real-time control of each order on the line is necessary.

Employees familiar with the job swipe the order bar code and do the work. The management will record the work results, then feedback the pass or fail results according to the processing output of the day but not the hour. Then the actual working results of each operator are shown directly at the machining line overtime on the screen, everyone can recognize the output of each processing worker with the required target according to the target time. The operator needs to explain that real-time understanding and monitoring information on the screen is essential.

5. CONCLUSION

The ERP system combines data on each module on the processing line, such as barcode, information, and RFID information, and an ERP system for product quality control and order control system for the same connection and data analysis. Real-time data helps departments control the performance of products that fail, the number of failures on each order at each processing line is convenient, the results are visible in the section conclusion.

In addition to tracking each order in real-time, the results demonstrate that reducing the dependency on human manipulation in swiping the order barcode at each processing line requires the operator to execute dimensioning products through the RFID system and scan the barcode on the order to finish the processing.

If the operator does not measure the product size after processing, or if the operator just processes one product and measures the dimensions for all remaining goods, the system will identify this and display a warning before locking the system again. In the future, integrating measurement data from the quality control ERP system into the machine condition control will improve the system maintainability for the machining line through the ERP system on the machining line.

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TÓM TẮT

ỨNG DỤNG DMAIC VÀ HỆ THỐNG ERP ĐỂ NÂNG CAO NĂNG LỰC VÀ CHẤT LƯỢNG TRONG CÁC CÔNG TY CƠ KHÍ: MỘT NGHIÊN CỨU

Nguyễn Minh Thư, Thái Thanh Sang, Trương Hoàng Khôi,
Dư Ngọc Bảo Trân, Nguyễn Thị Ánh Viên, Lý Đức Minh*
Khoa Kinh doanh Thương mại, Trường Đại học Văn Lang
*Email: *minh.ld@vlu.edu.vn*

Six Sigma là phương pháp phổ biến trong các hoạt động cải tiến quy trình, quy trình sản xuất nhằm nâng cao năng suất, chất lượng sản phẩm. Trong phương pháp tiếp cận Six Sigma, sử dụng chu trình Xác định - Đo lường - Phân tích - Cải tiến - Kiểm soát (DMAIC) để xem xét và kiểm tra những bất thường trong quá trình vận hành và có hành động khắc phục nhằm giảm thiểu những điểm nút thắt cổ chai nhằm nâng cao năng suất, ổn định chất lượng sản phẩm và làm cho chu trình sản xuất được liên kết chặt chẽ với nhau. Trong nghiên cứu này, tỷ lệ chậm trễ giao hàng hàng tháng là khoảng 6,28% sau khi áp dụng chu trình DMAIC trong phân tích trạng thái hiện tại của quá trình gia công và công cụ phân tích 5 lý do trong phân tích nguyên nhân gốc rễ của sự chậm trễ phát sinh sau đó tích hợp 2 mô-đun Hoạch định nguồn lực doanh nghiệp (ERP) để kiểm soát chất lượng sản phẩm và kiểm soát thông tin đơn hàng trong dây chuyền xử lý với chức năng Nhận dạng tần số vô tuyến (RFID) nhằm quản lý đơn hàng. Kết quả đạt được sau khi cải tiến là giảm tỷ lệ chậm giao hàng từ 6,28% xuống còn 0,02% theo từng tháng.

Từ khóa: RFID, ERP, DMAIC, Liên tục cải tiến, Lean Six Sigma, 5 Why.