

Improvement of Productivity by Using Means of Work Study, Continuous Improvement, Muda Elimination, and ECRS in Electronics Part Manufacturing: A Case Study of BBB Co., Ltd

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The study aims to make the working process better and improve productivity by using the technique of work study, continuous improvement, Muda elimination, and ECRS in electronics part manufacturing, which was investigated from November 2018 to March 2019, from a case study of the technical training department of BBB Co., Ltd. The data and information were gathered from supervisors and managers, and the problems were analysed by means of brainstorming together with the Ishikawa diagram. In reference to the findings, it was presented that crucial problems of the technical training department occurred from a delayed process in printing, grading, scanning examination results and storing paper exams, waste of paper exam usage, messy area due to paper exam storage, and erroneous grading scores. Considering the examination process, the whole processing of examinations could be changed from using paper exams to using online exams via the website of a company or QR code. Regarding the grading process, the grading process could be changed from a manual to an online system, which is accurate and prompt, to present the score immediately. The online examination can reduce usage of paper and printing ink, scanning and waiting time, and storage area. In addition, employees can test by themselves anytime, which helps them not to worry about their work and may result in higher scores. The standard time of the examination process was reduced from 5,769,535 seconds to 4,683,005 seconds per 3,035 persons, with productivity growth accounting for 23.20 percent of improvement. The examination cost was decreased from 124,957.53

THB to 97,562.60 THB per 3,035 persons, with productivity growth accounting for 28.08 percent of improvement. After applying online examinations, the findings showed that employee satisfaction level was increased from 3.21 to 4.10, the satisfaction improvement accounting for 27.73 percent.

Key words: *Continuous Improvement, Muda Elimination, Wastes, ECRS, Productivity.*

Introduction

At the present time, globalisation makes communication and operating businesses easier and faster, resulting in fierce competition, so both manufacturing and service companies need to find strategies that enable organisations to gain competitive advantage. Ferocious competition takes place in all enterprises, especially in electronics part manufacturing, which is competitive in features of good quality of products, lower price, fast delivery, and ability to meet customer requirements. In addition, the business success depends on the global economy, demand for electronic products, trade protectionism, opening countries, and free trade areas around the world. The above reasons have become an encouragement for organisations to be transformed to preserve themselves with the changing organisational situations. This has recently developed knowledge-based confrontation with the need of powerful management methods to help the organisation respond to the desires of customers. Throughout the previous durations, the modern management theories and principles have always been evolved, particularly novel concepts and principles of improvement of quality and productivity continuously developed. In addition, technology and information systems are gaining attention to be applied to improve productivity and quality.

BBB company limited operates in the design, manufacture, and distribution of electronic parts for domestic requirements, and for export to global markets; thus, there are a variety of types of products. Employees are required to pass basic skill tests before starting work for the production department, which leads to high levels of productivity and low levels of defects. Moreover, every three or six months, they need to take exams for qualified diverse advanced skills, depending on their responsibility. The technical training department reported that the waste problems included delays in the examination process, huge amounts of paper usage, and area loss for the storage of exam papers. In addition, quality problems occurred from both incorrect grading and filling exam scores. Thus, this study conducted the current examinations by investigating the quality and productivity improvement by implementing work study, continuous improvement, Muda elimination, and ECRS theories to get rid of waste and rectify the examination procedure to ensure that employees pass imperative skills

tests before working, which shall enable the enterprise to be extremely competitive in the manufacturing area.

Literature Review

Productivity

Productivity is widely defined as the proportion between the outputs or products created by a manufacturing or service process and the inputs or resources provided to obtain these outputs or products (Prokopenko, 1987). Therefore, the definition of productivity is the efficacious consumption of inputs such as man, machine, material, money, land, information, energy, and management, in the production of various outputs, both services and products (Drucker, 1999). Furthermore, high level of productivity is explained as the succeeding in greater amount of outputs with the same quantity of inputs or accomplishing better quality of products with the same resources (Kafle, & Fore, 2018; Ruch, 1994). In addition, Drucker (1999) proposed that productivity can be viewed as the productiveness and proficiency of performing a job.

All organisations are confronted with continuous and ruthless competition due to influence of globalisation; thus, numerous researchers have contended that the connotation of productivity as the quantitative relation between products and resources together with the definition of proficiency and productiveness generating from the consumption of the said input is restricted and unsuitable for evaluating the current organisational effectiveness (Lammon, 2010; Nissa, Jhatial, Nawaz, & Halepota, 2018; Riza, 2011). Consequently, recent concepts and principles of productivity encompass with social and ecological costs consideration, capability to comply with requirements of customers that are constantly changing, potential to establish value for all stakeholders in the supply chain, existence in radical competition, and alertness and quickness in making alterations to satisfy requirements of customers (Lammon, 2010; Riza, 2011).

Work study

An essential and well-known management tool to accomplish greater levels of productivity is called work study, involving labour work, the procedures of performing a job, and performance standardisation. The existence of any firm is reliant on utilisation of the most recent technology and innovation, and well organised production procedures. Besides, a company needs to consume resources efficiently, including employees, working areas, materials, machines and equipment. This can be succeeded by applying work study which studies methods and evaluates the performance. Study method will separate the working process into minor job elements, and then study minor job elements while searching and

analysing to delete, combine, or rearrange minor job elements to obtain the higher productivity or decreased cost.

Work study is described by the International Labor Organisation (ILO) as the means of study method or procedure and technique of measurement work utilised to endorse the excellent conceivable consumption of labour, material, and other resources to proceed for a designated activity. Besides, work study is a management technique constructed on study of method and procedure and measurement of work implemented in investigation of employee work, resulting in examination of all the inputs that affect proficiency and economy of situation in order to bring about improvement. In addition, the International Labor Organisation affirms that work study is aimed to diminish cost either by getting high productivity obtained from appropriate job design or by decreasing unavailing, loss, and wasted time to get greater productivity by improving current working procedures and methods (International Labor Organisation, 1986).

Kaizen

Kaizen is Japanese jargon, which means continuous improvement envisioned as numerous features. The first notion of continuous improvement relates to a philosophy involving a set of specific tools, means, or instruments employed to get better quality. Continuous improvement is important to organisational success; therefore, managers and supervisors have an attentiveness respecting working process focusing on the suitable procedure of operating jobs and duties. The second continuous improvement concept is comprehensive attributes, which emphasises the usefulness of performing incremental and continuous changes (Imai, 1986), to which practitioners have a focus on establishing little or slight changes, revising working methods, and eventually creating a considerable progressive outcome (Imai, 1986; Dertouzos, Lester & Solow, 1989; Nima, Nualdaisri, Tolaema, & Suteeravut, 2019). Although a substantial impact may not happen from each minor change or alteration, the continuing consequence can be absolutely profound. The third notion of continuous improvement can be explained as managerial techniques intended to improve both products and processes, which require participation from the whole of organisations' members, positions, and departments (Li, 2017; Poe, 1991). The intention of continuous improvement is to remove uneconomical executions (Robinson, 1991) and successfully bring about lean manufacturing (Dasig, 2017; Womack, Jones & Roos, 1990). Operators consistently get rid of the fatty tissues of business company and create procedures regarding lean manufacturing (Robinson, 1991). The final concept of continuous improvement is a classification of meditation perspective that reveals its abstruseness only through persistent replication and amendment (Anjani, & Baihaqi, 2018; Suzuki, 1987).

Practitioners endeavour to implement continuous improvement programs by using the PDCA-cycle, which is called the quality cycle of Deming. One cycle will be accomplished by working the sequential steps. One successful cycle may be appropriate for a period of time. Over time, the situation changes and then companies must develop a new cycle that is suitable for the changing situation. The Deming's quality cycle comprises four consecutive stages or phases. The first phase is the plan phase (P), which is intended to explore the processes or areas that have opportunities to change and improve. Practitioners analyse the areas or processes of interest to discover things that are possible to be modified or improved. The second phase is do phase (D), referring to the modifications or the alterations that are determined in the plan step. The next phase is check phase (C). The modifications, products or processes made in previous steps are measured and controlled to comply with organisational policies and the requirements of customers. The final phase is act phase (A), which involves with a response or an adoption to the modifications or setting modification products or processes to be standardised in order to maintain the continuous improvement cycle and handle the Deming's quality cycle through again (Heizer & Render, 2014).

Muda Elimination

Muda is Japanese jargon which is described as wastes and losses. Although the process is effective or efficient, there is generally some degree of wastes or losses. Considering the production process, wastes or losses refer to any activity assessed to be unnecessary or redundant activity. Customers assess that these activities do not increase any value; thus, the customers are not willing to pay for them. The Toyota Production System (TPS) is the cornerstone of the Japanese production system and is widely used around the world. Ohno is often coined as the pioneer of the Toyota Production System. Ohno (1988) distinguishes wastes or losses that emerge in process into seven categories, i.e. wastes from inventory, overproduction, waiting time, unnecessary transportation, over-processing, inefficient work methods, and defective products.

First, waste of inventory refers to things exceeding the smallest quantities and inoperative or redundant resources located in the production area and increasing production cost, for example, surplus finished products, works in process, raw materials, and superfluous operating suppliers. Second, overproduction refers to exorbitant utilisation of resources or output of the manufacturing process greater than the expectation of customers; or the products manufactured in advance before the requirements of customers. Third, waiting time involves the time consumed waiting between queues, activities, and inoperative time, which needs production space but does not increase any value. Fourth, unnecessary transporting is described as movement between activities or working stations which raise both handling and working in process, for instance, transporting resources between factories, production lines, or working stations with quantity of movement greater than one time. Next, over-processing

is explained as inessential manufacturing processes, scraps, including performing any job that exceeds the customer's requirement, which requires greater resources than actual requirements. Another example is inefficient work methods, which adds no value, diminishes productivity, enlarges quantity of work in the process inventory, superfluous transporting of equipment, and excess movement of workers. Finally, defective products refers to products that do not meet customer requirements, resulting in customer dissatisfaction. These defective products lead to higher scraps, rework costs, returns, and reduction in sale volumes (Heizer & Render, 2014). The possible success of continuous improvement can be achieved through the ability to identify the list of losses and wastes.

Principle of ECRS

Mogensen (1932) suggested an effective method of the technique of motion study known as ECRS technique applied to improve productivity and quality. E stands for eliminate loss or waste discovered in the production area. C stands for combine redundant work processes, which is aimed to decrease the number of working steps and reduce total manufacturing time. R stands for rearranging any process step purposes in order to reduce transporting distance or decrease the quantity of movements. S stands for simplify or propose easier methods for performing jobs or creating novel equipment or machine adjustment in order to support employees, such as support tools, jigs, and fixtures. ECRS is a pervasive technique used in any process which is confronted with unproductive working conditions associated with human works. The improvement from ECRS leads to depletion in system costs and energy costs, while the manufacturing time is diminished. Furthermore, material cost and waste cost are decreased when the improvements are effected to lessen material loss from improper working procedures or methods (Kasemset, Boonmee & Khuntaporn, 2016; Kitdumrongthum, & Thechatakerng, 2018).

Research Methodology

The investigation aims to increase productivity and quality of the examination process in electronics part manufacturing. The design of the study was action research, of which the period of study was between November 2018 and March 2019 in BBB Co., Ltd. Managers and supervisors were interviewed to comprehend current working conditions. Then, the data were observed and collected from the actual area. After that, problems were analysed by using brainstorming and Ishikawa diagram. The current productivity is calculated by the proportion between current output (number of employees who take the test) divided by current input (examination process time and cost). After calculating the present productivity, the process of analysis and improvement emerged through using work study, continuous improvement, Muda elimination, and ECRS principle. Then, the productivity of improved method was calculated by the proportion between output (number of employees who take the

test) after improvement, divided by input (examination process time and cost) used for improved method. The growth of productivity can be measured by the proportion between the difference of productivity of improved method and present productivity, divided by present productivity. In addition, employee satisfaction was assessed by questionnaires (5 refers to “extremely satisfied” and 1 refers to “extremely dissatisfied”). Descriptive statistic was used to analyse employee satisfaction data.

$$\text{Current Productivity} = \frac{\text{Current Output (number of employees who take the test)}}{\text{Current Input (examination process time /cost)}}$$

$$\text{Productivity After Improvement} = \frac{\text{Output After Improvement (number of employees who take the test)}}{\text{Input After Improvement (examination process time /cost)}}$$

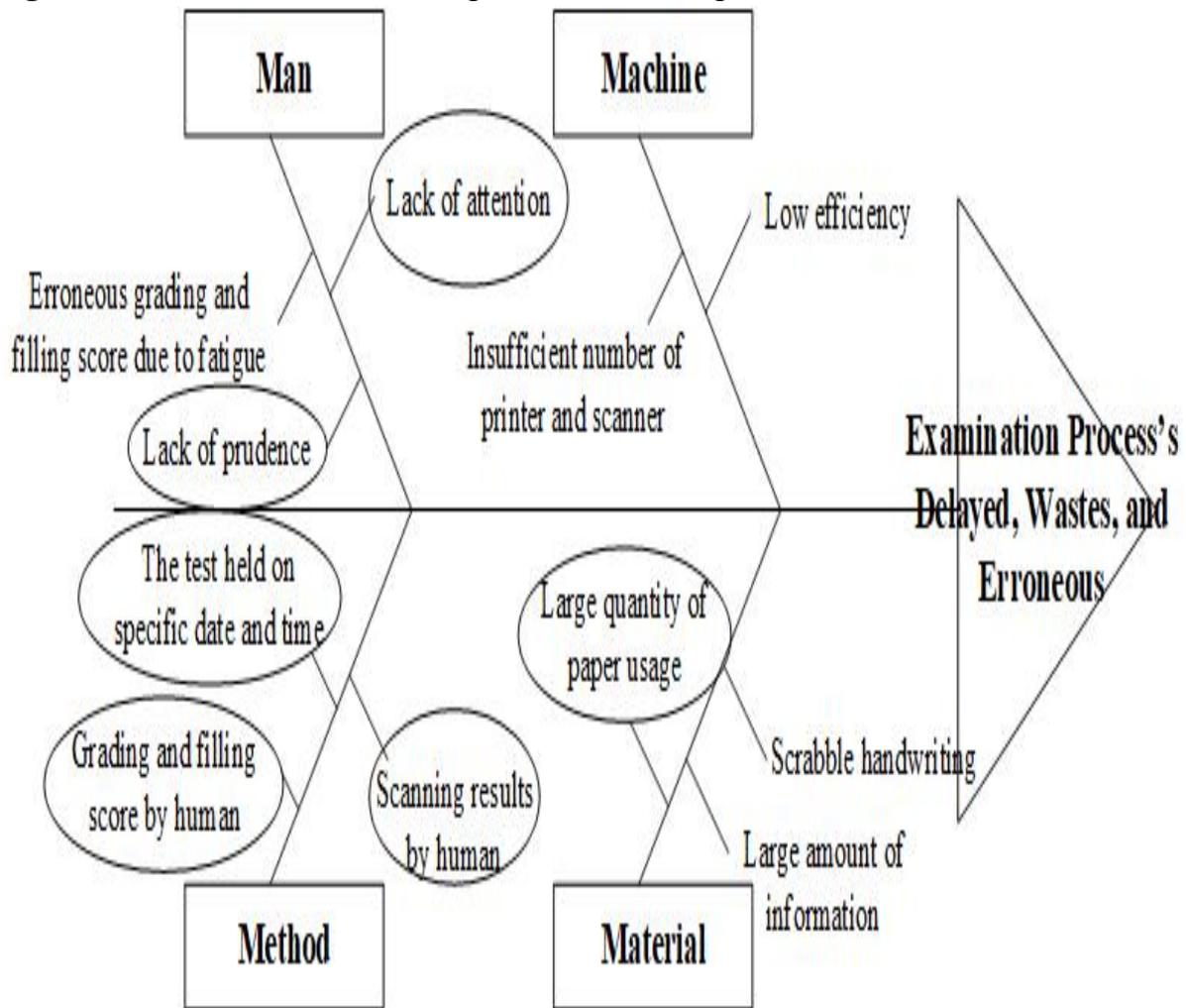
$$\text{Productivity Growth} = \frac{(\text{Productivity of Improved Method} - \text{Current Productivity})}{\text{Current Productivity}}$$

Research Results

The results from Brainstorming and Ishikawa Diagram

Figure 1 presents the problem analysis method using Ishikawa diagram studied by interview, observation, and participation together with brainstorming with relevant employees, supervisors, and managers. Regarding the results, it was revealed that pivotal problems of technical training department happened from the paper examination method, resulting in delayed processes in printing, grading, scanning examination results and storing paper exams, waste of paper exam usage, and messy areas due to paper exam storage. In addition, erroneous grading and filling scores occurred from human errors.

Figure 1. Results from Brainstorming and Ishikawa Diagram



Results of Improvement in Examination Process

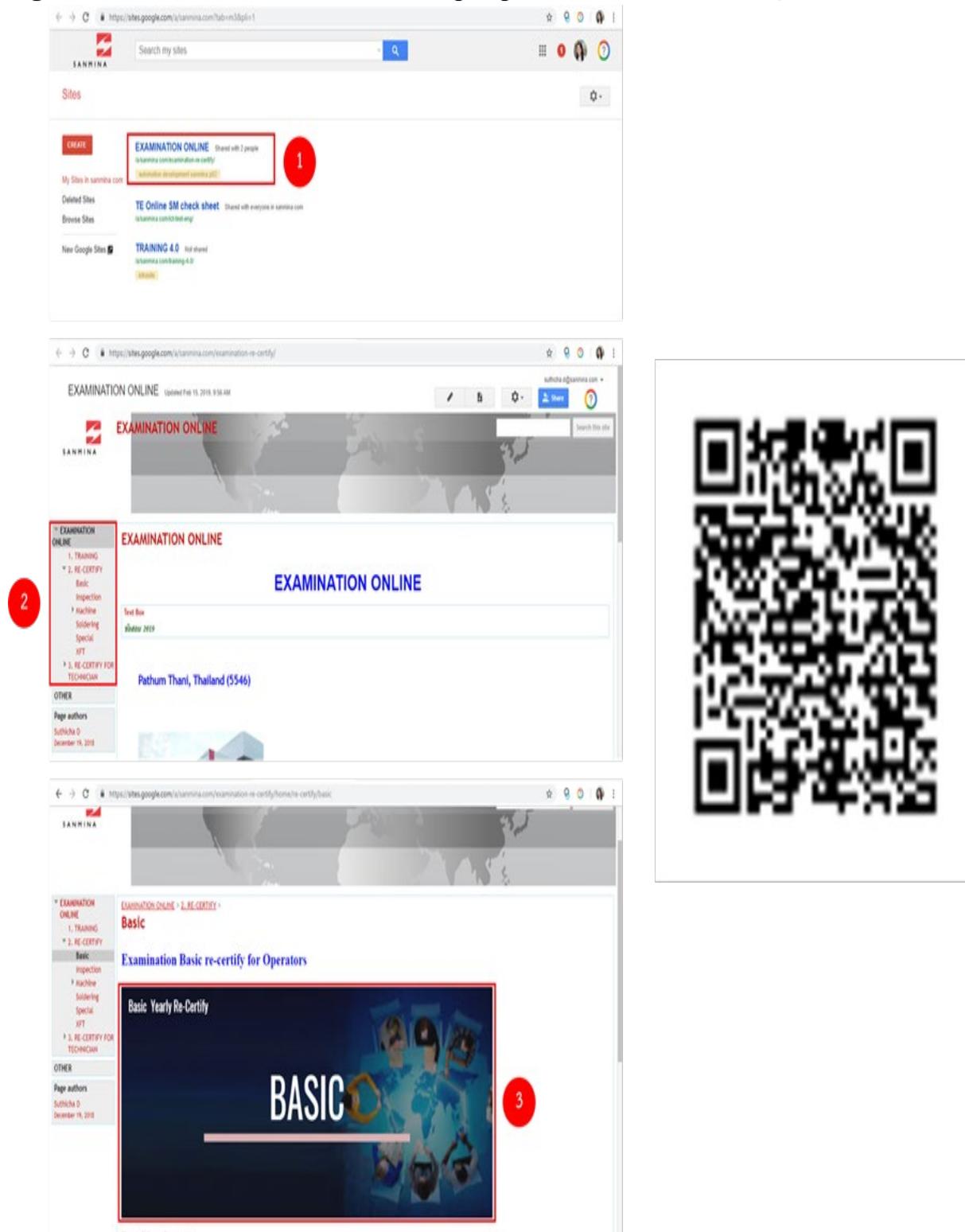
The examination process is important for the production department because it is used to assess employees' skills and assist managers to put the right employees to the right job. According to the rapid changing in requirements of electronic parts, the company launches a policy in which employees need to take the diverse skill examination every 3 or 6 months depending on their responsibilities. The large number of employees who take the test leads to a delayed examination process and incorrect results when checking and giving scores as well as keying results into computers. In addition, there are a huge quantity of examined papers which cannot be destroyed, resulting in loss of storage area due to utilisation of the areas for storing paper exams.

Considering work study, the findings revealed that employees need to take the test on specific dates and times, which leads to many pieces of paper exams in process of checking,



grading, and filling scores. ECRS was implemented, and it helped simplify the examination process. Considering the examination process, the examination method could be changed from using paper examinations to using online examinations. Regarding continuous improvement, PDCA-cycle was applied, in which the online examination questions were created by using google drive, generating QR codes and creating tool bars on company websites, which allowed employees to log in and do the test anytime by themselves, as shown in Figure 2. In addition, online examinations can compute scores and report results within a few minutes. Online examinations were used parallel with paper examinations between December 2018 and February 2019. Regarding the check phase, the employees' satisfaction was assessed by questionnaires, getting feedback by open-ended questions, and concluding improvement of the project. Then, the online examination system was improved and then changed to online examinations in March 2019. After applying online examinations, the results presented revealed that the standard time of the examination process was reduced from 5,769,535 seconds to 4,683,005 seconds per 3,035 persons, with productivity growth accounting for 23.20 percent of improvement. The examination cost was decreased from 124,957.53 THB to 97,562.60 THB per 3,035 persons, with productivity growth accounting for 28.08 percent of improvement. After applying online examinations, the findings showed that employee satisfaction levels were increased from 3.21 to 4.10, accounting for 27.73 percent of improvement.

Figure 2. Online Examination Access Using Organizational Website and QR Code



Discussions and Conclusion

The examination aims to achieve better productivity by using techniques of continuous improvement, Muda elimination, and ECRS in electronics part manufacturing. Brain storming and Ishikawa were applied to explore root sources of quality problems, wastes or losses, and delay in a process. Regarding the findings, it was revealed that critical problems of the technical training department emerged from a delayed process in printing, grading, scanning examination results and storing paper exams, waste of paper exam usage, messy areas due to paper exam storage, and erroneous grading scores. Considering the examination process, the whole process of examinations could be changed from using paper exams to using online exams via the website of the company or QR codes. Regarding the grading process, the grading process could be changed from grading manually to grading by online systems, which is accurate and prompt to present the score immediately. The online examination can reduce usage of paper and printing ink, scanning and waiting time, and storage area. In addition, employees can do the test by themselves anytime, which helps them not to worry about their work and may result in higher scores.

Referring to Kaizen, it can be envisioned as presenting comprehensive features which emphasise the value of making continuous incremental changes (Imai, 1986). Users emphasise making little modifications, changing working methods, and ultimately establishing a considerable intensifying effect (Imai, 1986; Dertouzos, Lester & Solow, 1989). Although each minor alternation may not have a substantial result, the continuous consequence can be absolutely profound. Corresponding with this study, the examination process was then changed from using paper to using online examinations, leading to a small investment but a huge impact. As the examination system is easy to access via the organisational website using computers, and QR Codes via smart phone, the rate of examinations is increased while standard time and costs are reduced. In addition, the present technology is essential for any business to solve productivity and service problems while aiming to increase customers' satisfaction and requirements. Since company operated in electronics parts, the decision to use technology can increase trust and enhance company image.

Kaizen is a Japanese lexicon known as continuous improvement, which is related to trivial cost or unimportant cost, but only increased careful scrutinisation of details and empirical methods can increase valuable results, which assists in performing things exclusively and tremendously effectively. The application of the continuous improvement will succeed through boundless communication, including downward and upward communication between the managers and the employees, horizontal communication between employees on the same hierarchical levels, diagonal communication across department or hierarchical levels, and grapevine communication, which is informal workplace communication. The effective shop

floor operators are specifically supported in order to participate and suggest any idea that establishes improvements (Saputro, Andre, Mokh, & Rita, 2018; Titu, Oprean & Grecu, 2010). According to the analysis of details, the findings asserted that there is numerous potential to make things superior once implementing the continuous improvement technique in working areas where modifications or improvements are not required. Based on the aforementioned, communication is important to the success of Kaizen implementation; thus, managers need to educate all employees in order for them to understand policy, effective performance, and benefits that they and the company will get from doing the continuous improvement program. As improvement takes a long time, they should not blame workers when the problems cannot be solved. Nevertheless, it is necessary to get feedback and collaboration from all members to obtain an incremental and sustainable improvement of organisational effectiveness.

The findings indicated that the execution of work study, continuous improvement, elimination of wastes or losses, and ECRS principles can be implemented in any company; both manufacturing and services firms as well as any size of company. These techniques originated from the Toyota Production System (TPS), which focuses on the energetic engagement of all levels of workers, intending to incorporate tiny developments but permanent improvements. Muda removal is one of the approaches to get rid of or decrease non value-added wastes or losses and improve production and organisational efficiency and effectiveness. In respect of work study, it is imperative that both method and time studies are simultaneously analysed. Modifying or adjusting method brings about diminishing of working time. Concerning improvement of method, it is not required to change or create new machines or equipment, because method can be made better by studying motion, procedure, and process, eliminating unnecessary motion and movements, and rearranging or excising superfluous processes. Considering notion of ECRS, all 4 principles are not required to be put into practice simultaneously, which is contingent on problem analysis and restrictions of each business firm. The findings presented that even though this investigation utilised only one concept of simplifying process, the improvements were at an acceptable level.

Training and skill tests for the employees can be considered as the improvement techniques of productivity and efficiency of employees. The outcomes indicated, however, that there are obstructions in the victorious application of the techniques of improvement for any improvement purpose. The most pivotal barriers endorsed are connected to insufficient communication, space between executives and operational employees, including the scarcity of appropriate training programs and enlightenment understanding of this activity amongst the operators. Thus, the complete benefits of the techniques of improvement cannot be well informed in the business firm whenever all the obstacles or barriers involved with utilisation of the techniques of improvement are identified, absolutely understood and manipulated. Endless measurement in all hierarchies or departments of a company is one significant

motivation to change the organisational improvement culture. This ceaseless measurement should be underlined on the development and improvement of productivity, product quality, extent of morale, level of employees satisfaction, amount of communication, insight understanding of communication, financial effectiveness, and satisfaction of customer.

Recommendations

There are some recommendations as below:

- 1) Ceaseless communications are important to the effectiveness of both Toyota Production System techniques and other management techniques originating from Japan. In addition, the Toyota Production System and Japanese management techniques should not be learned only from a classroom or through seminars; instead, it is necessary to study from the actual production area called Genchi Genbutsu. To be successful, all employees must be totally aware of the various classifications of waste or loss that can occur, and be consistently conscious of any occasions to assault and remove these wastes or losses. Top management must express their dedication to the improvement processes. There are several cases in which practitioners apply both Japanese and Western techniques at the same time, called the mixed improvement method. Too often, organisations use these processes as programs that can be started and terminated as desired. Business firms almost never supply them with the certain reinforcement and time in order to develop it into becoming a segment of the culture of business firm.
- 2) Since techniques of continuous improvement involve trivial cost and incremental changes over time, it is commonly used in any working area, not only manufacturing firms but also service industries. Moreover, due to improvements with lower resource investment, it can be executed in any size of firm such as small, medium, and large organisations.
- 3) This investigation implemented some of Japanese management and Toyota Production System techniques including work study, continuous improvement, Muda removal, and ECRS principle, and the findings are acceptable. However, there are several techniques that were not studied; so, the results may be corresponding or contradictory to this study. Thus, it is imperative for all companies to examine and choose techniques or tools appropriate for their working conditions, such as the lean manufacturing system, six sigma, lean six sigma, just in time (JIT), the push-pull system, Kamban, Poka Yoke, visualisation, Jidoka, single-minute exchange of die (SMED), Genchi Genbutsu, Hejunka, respecting workers, teamwork, and the system of suggestion.

- 4) In spite of the fact that the techniques of Toyota Production System and Japanese management are prevalently utilised in global business firms, management and techniques originating from Western and European regions are implemented pervasively as well. Considering that most Western and European management structures are related to forefront technologies, high efficiency machines, and novel innovations, which necessitate high amounts of investment, a business is required to evaluate break event point and length of payback before determining to invest in the implementation of novel innovation and forefront machines and systems. Moreover, practitioners should find the appropriate way to combine Japanese improvement style, which concentrates on skills and attention of employees, with Western improvement style, which emphasises technology and innovation.

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