International Journal on Advanced Science Engineering Information Technology

Vol.11 (2021) No. 1
ISSN: 2088-5334

Redesign Work Method Using Kaizen Engineering

Cut Ita Erliana[a,*], Syarifuddin[a], Ira Monika Br Ginting[a], Dahlan Abdullah[b]

[a]*Department of Industrial Engineering, Universitas Malikussaleh, Aceh, Indonesia*
[b]*Department of Informatics, Universitas Malikussaleh, Aceh, Indonesia*
Corresponding author: [*]cutitha@unimal.ac.id

***Abstract*—The technique of work procedures is studying techniques and principles to get the best work system design. One of the approaches in Redesign Work is Kaizen Engineering. The main advantage of Kaizen Engineering is increasing productivity, efficiency, and performance through the process of eliminating waste through small and continuous process improvements. One of the redesigns works processes that can be done is in the field of drinking water packaging. This research will be conducted at XYZ Ltd. as a mineral bottled water (in Indonesia known as Bottled Drinking Water / AMDK) company which was established in 1987. According to the observation, it is found that the number of demands is greater than the number of productions. The study's objective is to find out the proposed work method of XYZ Ltd. using kaizen engineering. The purpose is to make the packaging processing time shorter so that the number of produced products increased. Improvement was made by eliminating effective movements, bringing the layer table position closer, and creating a raft table design proposal to make the operators easier in doing their job. The time standard measurement result using the current work method is 70.98 seconds per person per cardboard. The measurement of the proposed work method improvement in the packaging processing decreased standard time to 55.54 seconds. It is 15.44 seconds or 21.75% lesser. This study showed that the proposed standard time could increase the output, reaching18 boxes per person per hour.**

***Keywords*— Mineral bottled water; kaizen engineering; motion; redesign work method.**

Manuscript received 15 Apr. 2020; revised 28 Dec. 2020; accepted 5 Jan. 2021. Date of publication 28 Feb. 2021.

I. INTRODUCTION

In Indonesia, industries develop and continually grow under the enhancement of technology and production, which is undeniably supportive for the existing industries. The development of technology has been tremendously impactful for various industries, both manufacturing and service industries. Along with the growth of community needs for products and services, it becomes one of the triggers for accelerating Indonesia's industrial growth.

Industries must be ready in advance to submerge in high competition to survive and obtain profit. While facing tightly high competition, a company needs to improve performance by putting effort into managing a well-established corporate management system to produce more effectively and efficiently, compete, and obtain a benefit. One of the ways to achieve this goal is to improve the production process. The production process needs to be continuously conducted to reduce material and time-wasting.

The Kaizen method is very commonly used for continuous improvement, which has been widely used in all company processes, such as for the prediction of material properties, which include using simulated annealing [1], determination of employee contributions [2], and quality improvement [3]. At present, managerial capabilities based on the Kaizen principle have increased rapidly along with increased activities that pay attention to productivity, growth, and longevity [4]. This is because Kaizen Engineering can improve efficiency and safety in carrying out organizations or companies [5].

Kaizen is derived from the word Kai which means Change, and Zen, which means to be fair, representing the philosophy of companies in Japan to improve manufacturing processes after World War 2, which significantly impacted the rapid growth of the industrial revolution in Japan [6]. The main advantage of Kaizen Engineering is increasing productivity, efficiency, and performance through the process of eliminating waste through small and continuous process improvements [7].

Lean-Kaizen means the elimination of activities (wastes) without added value (VA) through the adoption of small improvements [8]. The collection of lean tools and techniques, namely value flow mapping (VSM), poka-yoke, standardization, visual control, and Kanban cell manufacturing, is called a lean building block [9], [10]. Henry

Ford witnessed that standardization and innovation are equally essential for any organization. He suggested that LM and Kaizen tools are needed to identify opportunities to reduce waste and improve Grunberg [11] notifies that what is more important to do and how to improve in the process. Marvel and Standridge [12] suggest that selecting inappropriate lean tools causes several interruptions in the lean implementation process, which influences the expected results and reduces employee confidence in the organization, increasing several costs, waste, and production time.

XYZ Ltd. is a mineral bottled water (in Indonesia known as *Air Minum Dalam Kemasan/AMDK*) company established in 1987 located on *Pelabuhan Umum* Street, Number *A6, Blang Naleung Mameh, Aceh.* The company produces water in a cup (size 220 ml), bottles (medium size 550ml & 1500ml), and gallons (size19l) using *Mount Drink* as its brand. The Mount Drink production process is divided into two stages. Those are sterilization and packaging. In the packaging section, the process is carried out manually or using human power. The absence of standard time for the employees to complete their work causes uncontrolled working time since the employees work by keeping their working habits, leading to tiredness. Thus, the company is not able to meet consumers' demands (see Appendix I). Based on the above background, the researcher is interested in conducting a research entitled *"Redesigning Work Method Using Kaizen Engineering at XYZ Ltd."*. The study's objective is to find out the proposed work method of XYZ Ltd. using *kaizen engineering* at XYZ Ltd. This research will produce an improvement process related to improvement by eliminating effective movements, bringing the layer table position closer, and creating a table design proposal to make the operators easier in doing their job at XYZ Ltd.

Kaizen is not a new concept; it was first introduced in the late 1950s and the early 1960s by Deming [13] and Juran [14]. The Kaizen concept is process-oriented compared to Western thinking; it is more inclined to result-oriented reform [15]. Kaizen philosophy considers that our way of life, such as work-life or social life and household life, should be focused on continuous improvement. Improvements in Kaizen are small, and continuous Kaizen Work Culture has made many changes. Kaizen Work Culture has made many significant changes to many companies in Japan. One of them is Toyota, a company founded by Sakichi Toyoda, which has grown and established itself as a top-class company in the world [7]. Leading automotive companies from the United States (US) such as General Motor Corporation (GMC), Ford and Chrysler became frightened. Toyota and other Japanese brand vehicles are increasingly able to show their dominance and are welcomed by market share in the US, and with an ever-increasing trend. This caused many foreign companies (western companies) to see the Kaizen Work Culture as a work culture that they should also implement in their companies [16].

Core Kaizen: optimize costs and time to produce high-quality products. 5S (*Seiri, Seiton, Seiso, Seiketsu,* and *Shitsuke)* is the "Essence for Kaizen". This five-step plan is often called the five-S (5-S) movement: *Seiri* means activities to eliminate unnecessary items and sort and group items according to type and function. *Seiton* means arranging or placing materials and goods according to their place to be easily found or reached when needed. *Seiso* means cleaning all facilities and work environment from dirt and throwing trash in its place. *Seiketsu* means activities to maintain personal hygiene and always comply with the three stages above (*seiri, seiton, seiko*). *Shitsuke* means forming an attitude to meet or obey the rules and discipline regarding cleanliness and neatness of equipment and workplaces. The habit of the target to be achieved is establishing an independent attitude, a system of recognition of the workplace that has successfully carried out 4S successfully [17].

II. MATERIAL AND METHOD

Waste is defined as all work activities, which do not add any value in transforming input into output in the value stream mapping. There are seven commonly accepted types of waste: over production, waiting time, transportation, overprocessing, motion, inventory, defect products, and defective design [18].

Kaizen philosophy believes that life, work-life, social life, and household life should focus on continuous improvement. Although Kaizen improvement is small and gradually carried out, the Kaizen process can reach dramatic results[19].

"5S" is found in the list of five Japanese words starting with the letter 'S': *Seiri ,Seiton, Seiso, Seiketsu*, and *Shitsuke*. In Indonesian, these words is translated into 5R *Ringkas* (Sort) *Rapi* (Set in order), *Resik* (Shine/Sweep), *Rawat* (Standardize), and *Rajin* (Sustain/self-discipline) [20].

The work procedures technique is a study of techniques and principles to get the best work system design. The techniques and principles are used to manage the work system components encompassing humans with their nature and abilities, materials, spent equipment, used energy, and psychological and sociological effects. *Redesign* rooted from two syllables; re and design. The syllable *re* means repeats or redo. Thus, *redesign* means redoing the *design*. Redesign means reinvent something to make a change in appearance or function [21].

The research was conducted at XYZ Ltd., which is a mineral bottled water company located on *Pelabuhan* Street, Number *A6 Blang Naleung Mameh, North Aceh.* The research method can be seen in Figure 1.

The problem-solving methods that carried out are as follows:

- Analysis of an operator's work movements. Analysis of elements of the operator's work movements in one-box packaging of *Mount Drink Cup*.
- Analysis of the results of standard time measurements. After the standard time measurement is carried out, then the map is analyzed using the left-right hand.
- Analysis of Waste and 5S. Analysis of 7 waste and 5S packaging parts for *Mount Drink* Cup at XYZ Ltd.
- Design analysis of proposed improvements in the work methods with *Kaizen engineering*.

After improving work methods with the philosophy of *Kaizen Engineering*, then the results of the design improvement work method were analyzed.

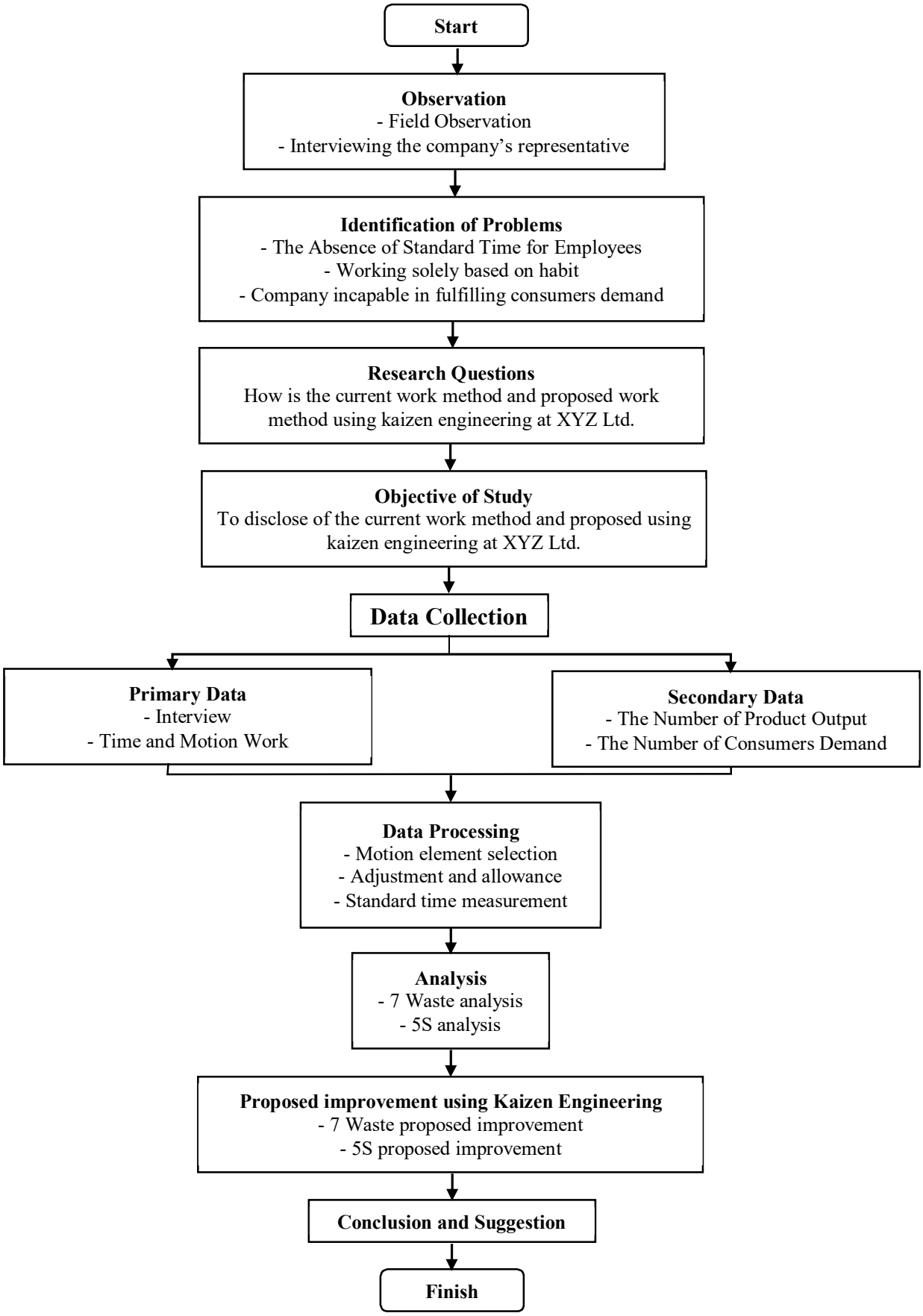

Fig. 1 Research Method

III. Result and Discussion

Based on the measurements that have been made, it can be seen the actual time of packing one carton of *Mount Drink Cup* for each operator one can be seen in Table 1.

TABLE I
Operator Actual Movement 1

Number	Element Movements	Actual Time (seconds)
1	Taking cardboard	3
2	Assemble the cardboard	4
3	Reverse the carboard	2
4	Putting the cardboard	2
5	Taking and arrange cup off the conveyer	10
6	Taking and put a layer	4
7	Taking and arrange cup off the conveyer	10
8	Move the cardboard that filled into the conveyor	4
	Total	39

Adjustment factors for the first Operator 1 to the sixth operator can be seen in Table 2.

TABLE II
Adjustment Factors 6 Operators

No	Factor	Class	Emblem	Adjustment
1	Skill	*Excellent*	B_2	+0.08
2	Effort	*Excellent*	B_2	+0.08
3	Condition	*Good*	C	+0.02
4	Consistency	*Excellent*	B	+0.03
	Total			+0.21

Based on the adjustment factors above, it can be calculated the normal time of packing the *Mount Drink Cup* from each operator in Table 3.

TABLE III
Normal Time of Packing Mount Drink Cup

Operator	Actual Time (seconds)	Normal Time (Seconds)
1	39	47.19
2	46	55.66
3	52	62.92
4	42	50.82
5	52	62.92
6	54	65.34

The calculation of the operator's allowance for packing *Mount Drink Cup* is shown in Table 4.

TABLE IV
Allowance

Factor	Interval Allowance (%)	Allowance (%)
A. Energy Release (can be ignored)	0.0–6.0	2
B. Work attitude (sit)	0.0–1.0	1
C. Work Movement (Rather limited)	0–5	2
D. Eye Fatigue (Continuous view)	6.0–7.5	6
E. The temperature of the crust (high)	5–40	5
F. Atmospheric state (enough)	0–5	2
G. Work Environment conditions (Repetitive work cycle)	0–1	1
Sub Total		19
Individual needs (woman)	2-5	2
An unavoidable obstacle		2.5
Total		23.5

Calculation of the standard time to each operator in Table 5.

TABLE V
Standard Time

Operator	Standard time (seconds)
1	58.28
2	68.74
3	77.71
4	62.76
5	77.71
6	80.69
Average	70.89

The initial Movement Element can be seen in Figure 2.

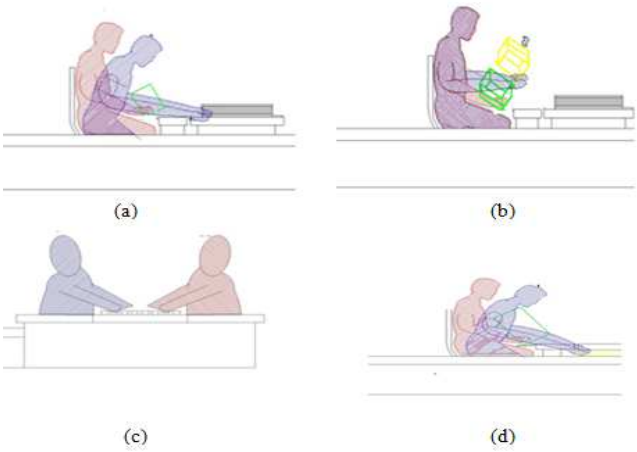

Fig. 2 Initial movement element

Analysis of 7 waste carried out using *kaizen engineering* in the packaging of Mount Drink Cup XYZ Ltd. is as follows:

- Overproduction: A fluctuating request of *Mount Drink Cup*.
- Defect: Happened when the lid and cup has leaked
- Waiting time: Downtime of the machine, length of the lead time for ordering raw materials, and transportation of its raw materials.
- Over Processing: When the Mount Drink Cup passes from the conveyer and falls into the container, then packing increases.
- Inventory: There is no safety inventory policy.
- Motion: Movement that is not effective.
- Transportations: Must be shortened as close as possible.

The results of the analysis with the 5S approach to its packaging work process are as follows:

- *Seiri* (selection): Some items are not used, such as container buckets and plastic chairs that are not suitable for use in this case for the packaging area.
- *Seiton* (arrangement): A cardboard placed is not in a proper place, a sack that contained a straw under the gluing table and not placed in the right area, and hanging clothes on the wall carelessly.
- *Seiso* (cleaning): The operator is still carelessly throwing garbage, such as duct tape, into a bucket of containers, putting the cardboard on the floor, so it does not get wet when the cardboard is on the floor, as in to support if there is any Mount Drink Cup falling and breaking from the conveyer, and putting their used as a

second glasses and paper and cardboard in the gluing machine

- S*eiketsu* (care): The application of the *seiketsu* in this section is not optimal.
- *Shitsuke* (diligent): Habit is still not implemented optimally by the workers who are responsible for this section

1) Proposed raft table:

The proposed Raft Table can be seen in Fig 3.

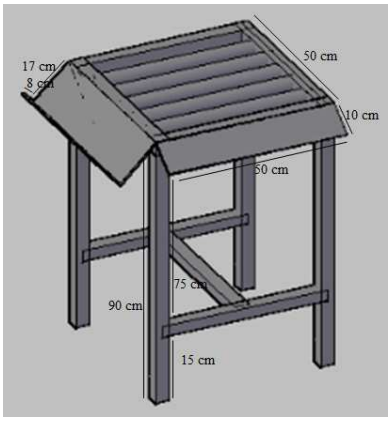

Fig. 3 Proposed Raft Table

2) Redesign work method: redesign work method can be seen in Figure 4. Figure 4 is the element of the proposed operator movement in the packaging Mount Drink Cup. Figure (a) is an element of the movement of picking up and assembling cardboard. Figure (b) is an element of movement in taking and arranging a cup. Figure (c) is an element of taking and laying a layer, taking, and arranging a cup, and moving the cardboard that is enveloped by a conveyer by pushing the cardboard.

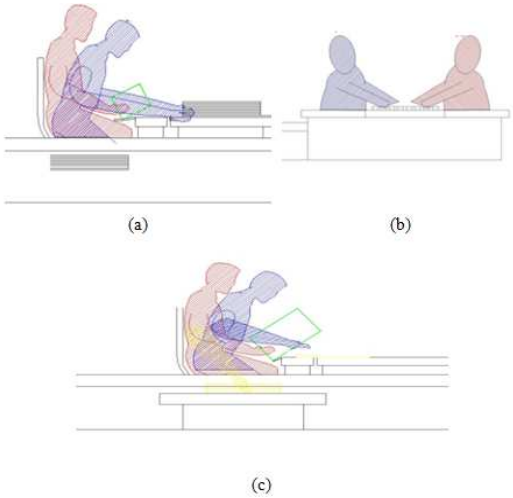

Fig. 4 Redesign Work Method

3) Packaging operator standard time: Packaging Operator Standard Time can be seen in Table 6.

Based on the analysis that has been done before on 5S, the recommendations for the company are as follows:

- *Seiri:* Sorting out items that are not needed anymore.
- *Seiton*: Arranging the items that have been sorted
- *Seiso*: Cleaning dirt that causes the packaging room has become a mess of dirt.
- *Seiketsu*: Taking care of the items and maintain the conditions that have been set.
- *Shitsuke*: Discipline and conduct audit regularly.

TABLE VI
PACKAGING OPERATOR STANDARD TIME

Operator	Cycle Time (second)	Normal Time (second)	Standard Time (second)
1	32	38.72	47.82
2	37	44.77	55.29
3	39	47.19	58.28
4	35	42.35	52.30
5	39	47.19	58.28
6	41	49.61	61.27
	Average		55.54

The time standard of comparison for packaging one cardboard Mount *Drink Cup* for each operator with the actual work method and proposed work method is shown in Table 7.

TABLE VII
COMPARISON OF STANDARD TIME

Work Method	Standard Time	*Output*/Hour/Operator (Cardboard)
Actual	70.98	51
Redesign	55.54	69
Difference	15.44	18

The proposed work method gives a shorter standard time than the actual work method with a difference of 15.44 seconds or equal to 21.75% with the proposed work method; the operator will be faster to complete the work, and the output produced will increase than usual. This research has produced an improvement process related to improvement by eliminating effective movements, bringing the layer table position closer, and creating a table design proposal to make the operators easier in doing their job at XYZ Ltd.

Kaizen has a significant impact on the overall work process. This can be seen from the impact given concerning maintenance and improvement [22]. Maintenance is related to maintaining current operational activities on technological, managerial, and operational standards. Meanwhile, improvement is related to innovation [23]. This study found that the proposed work method gives a shorter standard time than the actual work method with a difference of 15.44 seconds or equal to 21.75% with the proposed work method. The operator will be faster to complete the work, and the output produced will increase than usual.

Kaizen gives excellent results on redesign work because of its approach that provides convenience by paying attention to smaller tasks that are more manageable and easier to plan. Besides, this method can also increase productivity by eliminating unnecessary movements and operations. Another equally important thing is the principle of continuous improvement, which allows improvement in every aspect and process. This research has produced an improvement process related to improvement by eliminating effective movements, bringing the layer table position closer, and creating a table design proposal to make the operators easier in doing their job at XYZ Ltd.

IV. CONCLUSION

Kaizen is a small and gradual improvement, but the process can bring dramatic results over time. An essential aspect of Kaizen is to prioritize the process for improvement to increase productivity. The kaizen process does not stop after improvements have been successfully implemented, but every progress will be united as a new operational standard for work. However, today's standard applies until a new standard for improvement is found.

The working method of XYZ Ltd. has several ineffective movements carried out by the operator, which resulted in a long cycle of packaging processes. Improvement was made by eliminating ineffective movements, bringing the layer table position closer, and creating a raft table design proposal to make the operators easier in doing their job. The time standard measurement result using the current work method is 70.98 seconds per person per cardboard. The measurement of the proposed work method improvement in the packaging processing decreased standard time to 55.54 seconds. It is 15.44 seconds or 21.75% lesser. The proposed standard time is found able to increase the output, reaching 18 boxes per person per hour. This research produced an improvement process related to improvement were done by eliminating effective movements, bringing the layer table position closer, and creating a table design proposal as an effort to make the operators easier in doing their job at XYZ Ltd. Future research is expected to produce a road map for investigating opportunities to reduce costs and improve productivity and quality.

REFERENCES

[1] V. Veloso de Melo and W. Banzhaf, "Improving the prediction of material properties of concrete using Kaizen Programming with Simulated Annealing," *Neurocomputing*, vol. 246, pp. 25–44, Jul. 2017, doi: 10.1016/j.neucom.2016.12.077.

[2] M. G. Maarof and F. Mahmud, "A Review of Contributing Factors and Challenges in Implementing Kaizen in Small and Medium Enterprises," *Procedia Economics and Finance*, vol. 35, pp. 522–531, Jan. 2016, doi: 10.1016/S2212-5671(16)00065-4.

[3] P. Knechtges and M. C. Decker, "Application of Kaizen Methodology to Foster Departmental Engagement in Quality Improvement," *Journal of the American College of Radiology*, vol. 11, no. 12, Part A, pp. 1126–1130, Dec. 2014, doi: 10.1016/j.jacr.2014.08.027.

[4] Y. Mano, J. Akoten, Y. Yoshino, and T. Sonobe, "Teaching KAIZEN to small business owners: An experiment in a metalworking cluster in Nairobi," *Journal of the Japanese and International Economies*, vol. 33, pp. 25–42, Sep. 2014, doi: 10.1016/j.jjie.2013.10.008.

[5] A. Kapur *et al.*, "Improving Efficiency and Safety in External Beam Radiation Therapy Treatment Delivery Using a Kaizen Approach," *International Journal of Radiation Oncology*Biology*Physics*, vol. 96, no. 2, Supplement, p. S73, Oct. 2016, doi: 10.1016/j.ijrobp.2016.06.186.

[6] H. A. Tetteh, "Kaizen: A Process Improvement Model for the Business of Health Care and Perioperative Nursing Professionals," *AORN Journal*, vol. 95, no. 1, pp. 104–108, Jan. 2012, doi: 10.1016/j.aorn.2011.11.001.

[7] M. P. D. Robert, *One Small Step Can Change Your Life: The Kaizen Way*, First Printing edition. New York: Workman Publishing Company, 2014.

[8] S. Kumar, A. K. Dhingra, and B. Singh, "Process improvement through Lean-Kaizen using value stream map: a case study in India," *Int J Adv Manuf Technol*, vol. 96, no. 5, pp. 2687–2698, May 2018, doi: 10.1007/s00170-018-1684-8.

[9] G. Alukal and A. Manos, *Lean Kaizen: A Simplified Approach to Process Improvements*. Milwaukee, Wis: ASQ Quality Press, 2006.

[10] J. P. Womack and D. T. Jones, *Lean Thinking : Banish Waste and Create Wealth in Your Corporation*. London: Simon & Schuster Ltd, 2003.

[11] T. Grünberg, "A review of improvement methods in manufacturing operations," *Work Study*, Apr. 2003, doi: 10.1108/00438020310462890.

[12] J. H. Marvel and C. R. Standridge, "Simulation-enhanced lean design process," *Journal of Industrial Engineering and Management*, vol. 2, no. 1, pp. 90–113, Jul. 2009, doi: 10.3926/jiem..v2n1.p90-113.

[13] W. E. Deming, *Elementary principles of the statistical control of quality;: A series of lectures*, 2nd edition. Tokyo: Nippon Kagaku Gijutsu Remmei, 1952.

[14] J. M. Juran, L. A. Seder, and F. M. Gryna, Eds., *Quality Control Handbook*. New York: McGraw-Hill Book Company, 1951.

[15] A. Chakraborty, M. Bhattacharya, S. Ghosh, and G. Sarkar, "Importance of Kaizen Concept in Medium Manufacturing Enterprises.," *International Journal of Management Strategy (IJMS)*, vol. 4, no. 6, pp. 1–11, 2013.

[16] N. Štefanić, N. Tošanović, and M. Hegedić, "Kaizen workshop as an important element of continuous improvement process," 2012.

[17] S. Kumar, A. K. Dhingra, and B. Singh, "Kaizen Selection for Continuous Improvement through VSM-Fuzzy-TOPSIS in Small-Scale Enterprises: An Indian Case Study," *Advances in Fuzzy Systems*, Jul. 12, 2018. https://www.hindawi.com/journals/afs/2018/2723768/ (accessed May 31, 2020).

[18] V. Gasperz and Avanti, *Lean Six Sigma for Manufacturing and Services*. Bogor: Vinchirsto Publication, 2011.

[19] M. Imai, *Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy*, 2 版. New York: McGraw-Hill Professional Pub, 2012.

[20] Y. Monden, *Toyota Production System: An Integrated Approach to Just-In-Time, 4th Edition*, 4 edition. Boca Raton: Productivity Press, 2011.

[21] I. Z. Sutalaksana, *Teknik Perancangan Sistem Kerja*. Bandung: Penerbit ITB, 2006.

[22] D. R. Kiran, "Chapter 11 - Kaizen and continuous improvement," in *Work Organization and Methods Engineering for Productivity*, D. R. Kiran, Ed. Butterworth-Heinemann, 2020, pp. 155–161.

[23] Y. Umeda *et al.*, "Exercise of digital kaizen activities based on 'digital triplet' concept," *Procedia Manufacturing*, vol. 45, pp. 325–330, Jan. 2020, doi: 10.1016/j.promfg.2020.04.025.