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Measurement And Utilization Of “Free Capacity” At Production Sites: Based On The Theory Of Gemba Kaizen Costing

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ABSTRACT

Accounting has the potential to become a useful communication tool for lean enterprises. In this study, we specifically developed Gemba Kaizen Costing (GKC), which is a new accounting theory and tool that contributes to Gemba Kaizen. The GKC theory is a basic accounting theory based on the Toyota Production System (TPS) and the “design-information view of open manufacturing” theory proposed by Dr. Fujimoto. We apply the GKC by conducting an action research by partnering with Japanese companies, particularly Yabashi Holdings Co., Ltd. Our research shows that GKC can map out people's improvement activities and their outcomes in Gemba.

Keywords: Gemba Kaizen, Kaizen effects, Gemba Kaizen Costing (GKC), Surplus Production Capacity, Free Capacity

1. INTRODUCTION

For companies worldwide, global competition is no longer unusual and has become an inevitable part of operation. For Japanese companies, using “Kaizen,” or continuous improvement, to become a lean organization has been shown to be one of their major strengths. Gemba is a Japanese term that means the actual and real place. In the words of Womack (2013), “Gemba. What a wonderful word. The place – any place in any organization – where humans create value” (Womack, 2013, p.xix). Gemba Kaizen is an approach defined by Dr. Shingo, an emeritus professor at Utah State University who the Shingo Prize is named after. Dr. Shingo describes Kaizen as “improvement, the act of bettering things beyond their current status” (Shingo, 2007, p.13).

To secure customer satisfaction and earn profit, accounting control must be incorporated into business management. Accounting control and behavior control by Gemba Kaizen are the two established methods required in the field of management control. It is essential to develop a new accounting theory that connects these two types of control within the context of accounting.

This study proposes the Gemba Kaizen Costing (GKC) theory, which is a new accounting theory that can promote improvement, and demonstrate its effectiveness through practical application. Our research approach is divided into two stages. First, we develop GKC as a new basic accounting theory based on previous accounting research and manufacturing management practical knowledge, particularly the Toyota Production System (TPS) and the “design-information view of open manufacturing” theory proposed by Dr. Fujimoto (1999, 2007, 2012). Second, we conduct an action research by partnering with Japanese companies. In this study, we specifically build our action research based around Yabashi Holdings Co., Ltd.

2. PREVIOUS RESEARCH

2.1. Cost accounting aimed at cost control

Cost control is the main purpose of cost accounting. Standard costing, activity-based costing (ABC), activity-based management (ABM), and time-driven activity-based costing (TD-ABC) are representative cost accounting approaches oriented toward cost control.

In standard costing, each standard cost is determined in advance based on some criteria. Its variations are calculated and managed only from the normal standard. However, in Gemba, which evolves day by day, it is necessary to calculate the difference before and after each Kaizen. Activity-based costing is a realistic allocation of manufacturing overhead costs. Activity-based management focuses on a Customer Value of Activities. Time-driven activity-based costing shows the possibility of calculating unused capacity.

As Gemba Kaizen began attracting more attention, the concept of Muda (waste) was also noticed. While considered useful, the aforementioned accounting techniques can

only be used to control manufacturing overhead costs and do not account for Muda in each activity.

2.2. Cost accounting focused on Muda and capacity

There are different types of cost accounting measures that consider the amount of Muda included in costs. In material flow cost accounting (MFCA), all output cost information, including non-product information (so-called material loss), are shown. While it is considered a useful method, material flow cost accounting is only limited to material costs and does not consider Muda in processing costs.

CAM-I full capacity model, which was developed in collaboration with practitioners, classifies various capacities from the Gemba perspective (Klammer, 1996), but only focuses on time capacity within 24 hours and 365 days. The theory of constraints (Goldratt, 1984) focuses on the bottleneck process of the production site while inheriting the TPS concept; during this process, the production line capacity is at its lowest, obstructing the progress of production. The theory claims that throughput, inventory, and operating expenses should be managed (Goldratt, 1990). By comparing how much these expenses amount to before and after the implementation of Kaizen in each category, the proposed theory assesses the realized effects of Kaizen. However, it does not address and use the “Free Capacity” caused by improvement because of Kaizen.

2.2.1 Lean accounting

Lean manufacturing was developed from TPS, a theory established by Ohno in his book “Toyota Production System” (Ohno, 1978). After the book was translated into English (Ohno, 1988), the concept of Kaizen and the productivity of the Japanese manufacturing industry, including Toyota, began attracting more attention. More companies then began to introduce and practice lean manufacturing (Womack, 1990, 2003; Modig and Ahlstrom, 2012). From lean manufacturing came lean accounting, which is the “Gemba Management Method” proposed from the Kaizen perspective. Lean accounting was proposed as an accounting technique to address lean production systems (Huntzinger, 2007; Stenzel, 2007; Maskell et al., 2012; Katko, 2021). Based on lean thought, the accounting calculation structure in lean accounting should be as lean as possible. Several tools for lean accounting have been proposed.

The first is the box score (Maskell et al., 2012). As a feature of the box score, numerical values required by the management function are organized into three groups: production management indicators, capacity, and performance indicators for the entire company. In lean accounting, we compare two cases of the utilization of capacity as a result of improvement through the Kaizen effects: when capacity is reduced, and when it is applied to a new business. In this way, one can assess the benefits of surplus capacity in the future. The box score can be used to examine the current situation and to simulate future situations under different conditions (Katko, 2021). However, the accounting principle

according to which usage capacity is divided into “net work,” “Muda,” and “non-value-added work” is not considered.

The second tool is value stream costing (VSC) (Maskell et al., 2012). The flow of activities from product development to the reception of products by customers is called value stream. All costs generated by the value stream are tabulated, and profit is calculated. This can be thought of as a simple process costing for each value stream. However, although the calculation is straightforward, it is difficult to obtain accurate estimates of product costs. In addition, the assessment of the Kaizen effects in individual processes is not provided.

The third tool is sales operational and financial planning (SOFP) (Maskell et al., 2012). The value stream of the SOFP is the entire process from order reception to production, sale, and collection of payment. Then, the sales plan, new product introductions, operations capacity plan, and financial plan for the value stream of each product or product group are created and reviewed monthly. In lean accounting, this is called “Integrated Game Plan” (Maskell et al., 2012). However, as with box scores, SOFP is just a list of various numbers and does not specialize in data that contributes to Kaizen.

While the lean accounting method and its tools were proposed from the Kaizen perspective, it minimizes accounting calculations, which has led to “poor accounting communication.”

2.3. Kaizen effects measurement in Japan

In this section, we examine the attempts to measure Kaizen effects in the Japanese company that pioneered the Gemba Kaizen. “KAIZEN generates process-oriented thinking, since processes must be improved before we get improved results. [...] This contrasts sharply with the result-oriented thinking of most Western managers (Imai, 1986, p.16). “In the Gemba, the supervisor manages inputs to produce outputs. [...] The output is quality, cost, and delivery, or QCD” (Imai, 2012, p.117). Therefore, the measurement of Kaizen effects in Japanese companies has traditionally been managed and evaluated by the QCD index. However, attempts were also made to measure its economic effects, including the Kaizen effects, on the management of companies. For instance, between the 1960s and the 1970s—a period of significant economic growth in Japan—Professors Senju and Fushimi proposed the so-called “Engineering Economy” of corporate activities (Senju & Fushimi, 1982, 1983; Senju et al., 1986). Professor Okamoto examined cost reduction and the measurement of its economic impact and showed that Kaizen effects could be classified as realized and unrealized (Okamoto, 2000).

These studies share the common argument that Kaizen practices in Japanese companies are often observed and monetarily assessed before and after corporate improvement. However, the creation of surplus capacity and its utilization have not been addressed in the literature. Our study contributes to the existing literature by enhancing the visibility of Kaizen effects as expressed in monetary terms using the concept of capacity (Hiiragi

& Kazusa, 2016, 2017a, 2017b, 2022; Hiiragi, 2019, 2020, 2021; Kazusa, 2018). In the following section, we discuss the GKC theory concerning capacity.

3. GEMBA KAIZEN COSTING

In this section, we first consider the “Gemba Kaizen and Management Innovation Cycle” (Kazusa, 2016), a fundamental concept of GKC. We observe an increase in capacity during a cycle when Gemba Kaizen is implemented. Then, the development of the capacity at the Gemba is schematized. Furthermore, because of Kaizen, we identify damages in the capacity; that is, where Muda is generated, and make improvements accordingly. Thereafter, the Kaizen effects are identified and a calculation method to measure them is proposed.

3.1 Gemba Kaizen and Management Innovation Cycle

“Opportunity loss” is an essential concept in the relationship between Gemba Kaizen and increased capacity. The importance of opportunity loss in Japanese management was first proposed by Kazusa (2016). Figure 1 shows the Gemba Kaizen Cycle during the economic growth period, and Figure 2 describes the Gemba Kaizen and Management Innovation Cycle by incorporating the opportunity loss concept.

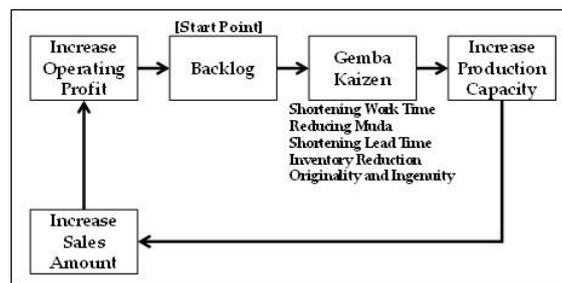


Figure 1 – Gemba Kaizen Cycle (economic growth period)

Source: Kazusa (2016), p. 9

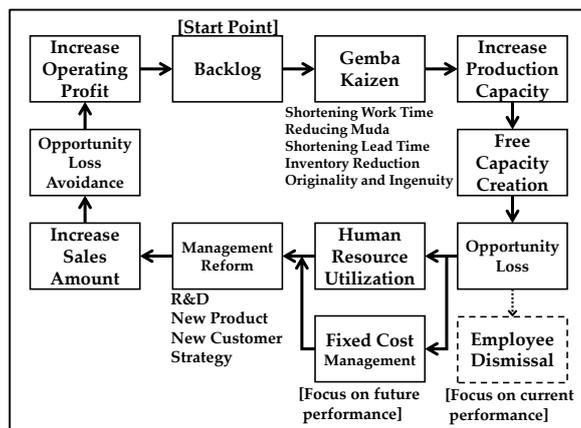


Figure 2 – Gemba Kaizen and Management Innovation Cycle

Source: Kazusa (2016), p. 11, partly modified

In the 1960s and 1970s, when TPS was developed and established, the Japanese economy experienced a period of significant and stable economic growth. As shown in Figure 1, if capacity increases without Muda, production sites that otherwise could not catch up with demand can accept more orders, thereby increasing sales and directly increasing profits. However, as stated by Hiiragi and Kazusa (2016), “with the collapse of the bubble in 1992, continuous high growth has ended, where demand cannot absorb the increase in capacity, resulting in surplus capacity and thus opportunity losses occurred.” Many Japanese companies have tried to minimize employee dismissals and factory closures when surplus capacity occurred. Instead, they tried to understand and utilize the surplus capacity by acquiring new customers, products, and businesses. This is a feature of what is referred to as Japanese-style management. Figure 2 shows this cycle.

3.2. Capacity Transferred Eiagram: “Kaizen Map”

One of the fundamental ideas of TPS is to analyze in detail whether the work is truly valuable for customers. Ohno Taichi, who is considered the creator of the TPS, a systematic method of Gemba Kaizen, defined the concept of Muda and other works at the production site: “Careful inspection of any production area reveals waste and room for improvement. [...] Through close observation, we can divide the movement of workers into waste and work (Ohno, 1988, p.57). Figure 3 shows those divisions.

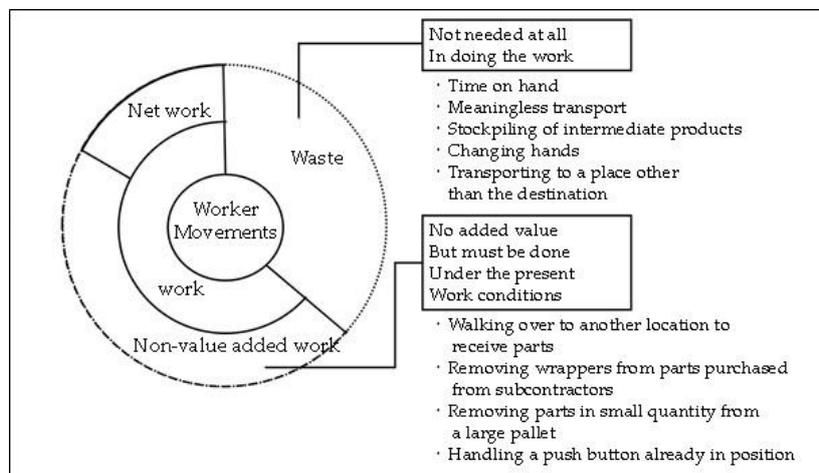


Figure 3 – Understanding the manufacturing function

Source: Ohno (1988), p. 58

As described by Mr. Ohno, “we can divide the movement of workers into waste and work” (Ohno, 1988, p.57). He divided the movement of workers into: (1) waste, which is “the needless, repetitious movement that must be eliminated immediately. For example, waiting for or stacking subassemblies” (Ohno, 1988, p.57); and (2) work, whose two types are “non-value-added work and value-added work” (Ohno, 1988, p.57).

The above classifications can be similarly utilized for the movement of workers and machines as well as all activities directed toward customers. It is an epoch-making way

of Gemba Kaizen thinking, and it is recommended that the same idea also be applied to accounting. Therefore, a theoretical method that can be monetarily measured is required; that is, the true visualization of the Kaizen effects by accounting.

We propose GKC as a new accounting theory for assessing the Kaizen effects and all production capacities, including “Free Capacity” created by Kaizen in monetary terms. Based on the practice of production sites, GKC is a management accounting theory that involves both production management and accounting. We present below an overview of this theory and an example of its actual application.

Figure 4 shows the “Capacity Transferred Diagram” (Hiiragi & Kazusa, 2022) named “Kaizen Map” of the GKC. In the production process, from the introduction of production resources on the left-hand side of Figure 4 to the delivery of good products to the customer on the right-end side, the diagram indicates the contribution of the maximum capacity to customer demand. Kaizen Map clarifies the extent to which the input production resource is damaged and at which stage of the production process.

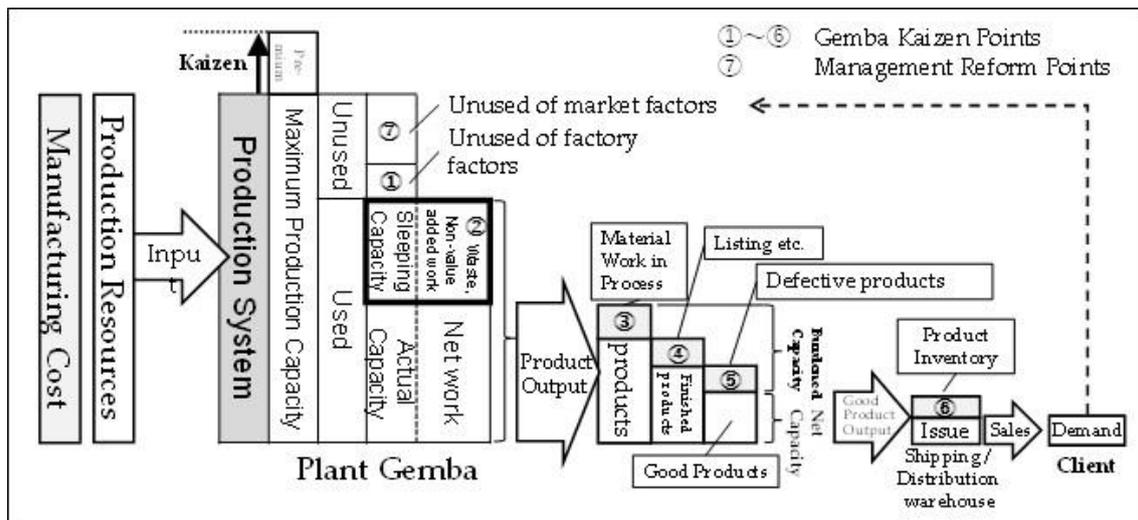


Figure 4 – Capacity Transferred Diagram “Kaizen Map”

Source: Hiiragi and Kazusa (2022), p. 132, modified by the author

The production resource input on the left-hand side of Figure 4 is determined by the production system as the maximum capacity of the enterprise. Maximum capacity is divided into “used” and “unused.” Used capacity is a “state wherein capacity is used for good products.” Unused capacity is classified as follows: ① “Factory oriented unused capacity” (e.g., shops, machinery); and ② “market oriented unused capacity” (i.e., products that are no longer wanted by customers). Some elements of used capacity cannot contribute to the production of good products. In the used capacity reported in Figure 4, only the value-added working time was used for producing output. Waste and non-value-added work cannot be included in the value-added net capacity. This damage in the capacity is termed “sleeping capacity” and is an essential point in Gemba Kaizen.

The direct work time targeted by previous cost accounting principles corresponds to the used resources in Figure 4. Processing costs in conventional cost accounting also include the costs for Muda and non-value-added time, which were not utilized in output production. In the GKC theory, we proposed to subdivide the time breakdown of conventional cost accounting to solve this problem (Hiiragi & Kazusa, 2017a).

On the right-hand side of Figure 4, from the output production arrow to the good production arrow, capacity is sorted out depending on whether or not output contributes to delivering good products to the customer. Based on the GKC theory, only the portion of the used capacity that contributes to the production of good products is defined as net capacity. Cases in which the capacity has been used to produce output, but has not been utilized for the production of good products, involve ③ material inventory or work in progress, ④ end materials, and ⑤ defective products. Cases in which the capacity has been used to produce output, but has not been utilized for the production of good products, involve material inventory or work in progress, end materials, and defective products. All such cases imply the presence of capacity that has not yet reached its final destination—we refer to these cases as “burdened capacity” in GKC.

Finally, not all output reaches the customer in the form of good products. Steps ① to ⑥ in Figure 4 denote Muda at each stage of the production process. In other words, the “Gemba Kaizen Point” needs to be improved. In addition, ⑦ shows the unused productivity of market factors and is called “Management Innovation Point.”

4. CATEGORIZATION OF GEMBA KAIZEN EFFECTS

When production capacity increases because of improvement from Kaizen, the outcome changes. Three important conditions occur in this situation. Figure 5 is a simplified version of the Kaizen Map shown earlier, wherein resources are inputted into a certain production system (Hiiragi & Kazusa, 2022). There are resources that do not contribute to good production even though they were inputted and became capacity. Moreover, even if they are converted into good products, they become wasteful if the product remains in the product inventory because the customer does not buy it. Kaizen is used to eliminate this Muda.

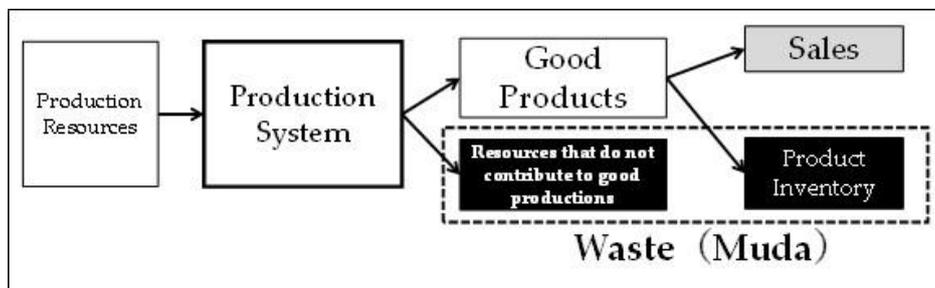


Figure 5 – Definition of Muda by GKC
 Source: Hiiragi and Kazusa (2022), p. 131

Muda reduction increases good production. In other words, the market decides whether to increase production. To be precise, Muda reduction improves the conversion efficiency in production systems. How can we make use of this improved conversion efficiency? Figure 6 shows two ways how to use the Kaizen effects (Hiiragi & Kazusa, 2022).

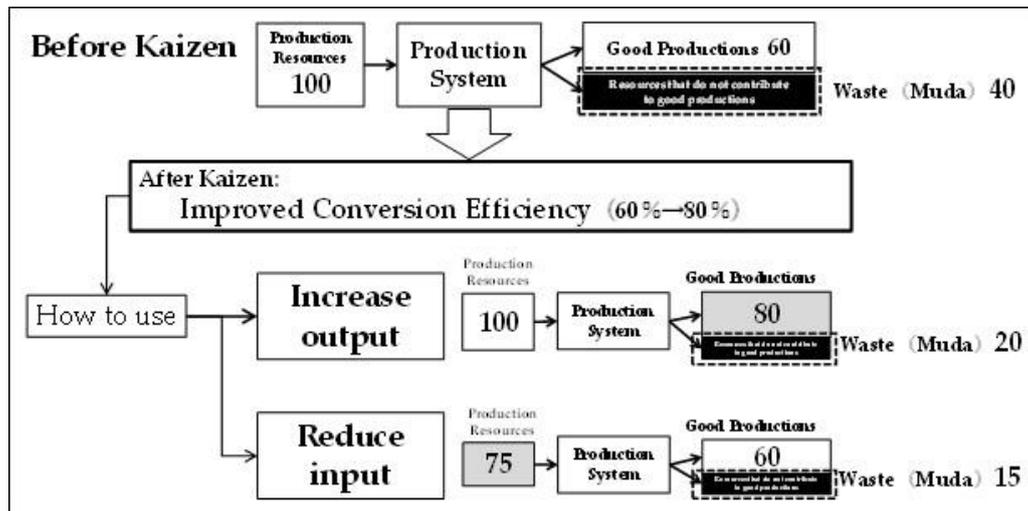


Figure 6 – Improved Conversion Efficiency

Source: Hiiragi and Kazusa (2022), p. 134, modified by the author

One way is to increase output and the other is to reduce input. With Kaizen, many outputs can be realized for the same input. When there is sufficient market demand, the company can have more room to increase production. The other way is to save the input required for the same output. Moreover, for resources, the difference between being variable, that is, whether it is a variable cost in accounting or a fixed cost, has an effect. Regarding input resources, the difference between variable costs and fixed costs also affects the results. Figure 7 shows a visualization of the Kaizen effect by the GKC (Hiiragi & Kazusa, 2022).

Based on the two simple logics in Figure 6, we organize how the Kaizen effect brings about accounting results, which are reflected in Figure 7. The path to accounting results starts from the physical Kaizen effect at the top left of the figure.

The first branch is the presence or absence of market demand. If something is in demand, its output can be increased, which directly realizes increased sales. This process represents the realization of the simplest Kaizen effect. In contrast, increasing production even without demand will only increase product inventory. This outcome is represented by the dotted line box, which indicates unfavorable result.

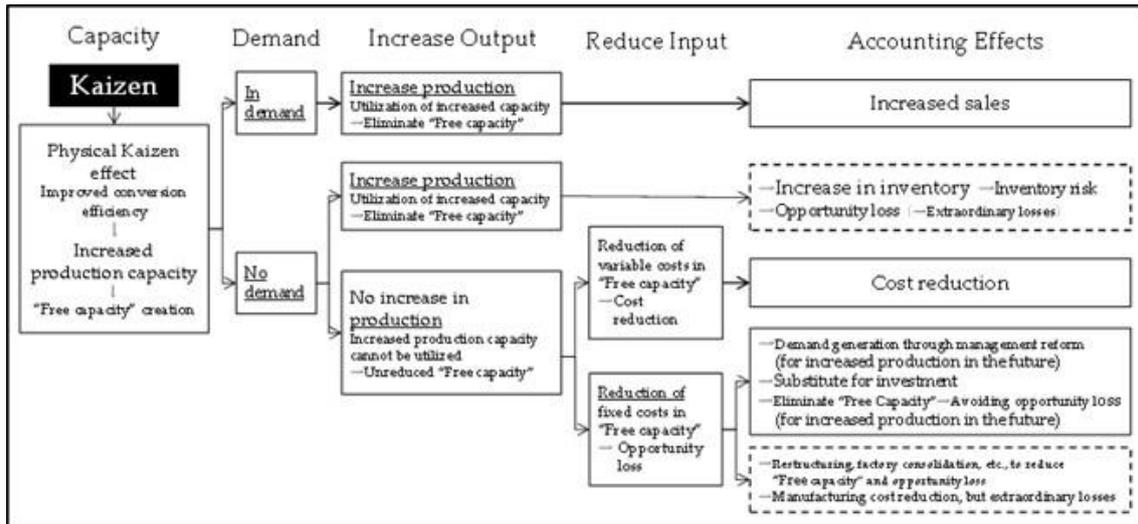


Figure 7 – Categorization of Gemba Kaizen effects

Source: Hiiragi and Kazusa (2022), p. 137

If production is not increased because there is no demand, input can be reduced. If the resources and capacity are variable costs, they can easily be reduced. This step realizes a cost reduction. However, if the costs are fixed costs, reduction is not easy to achieve. In this case, restructuring should be avoided, as described in the dotted line box at the bottom right corner of the Figure 7. The road to polar star is the demand generation through management reform to take advantage of fixed-costs capacity. Substitutes for investment may be realized by utilizing the surplus capacity, called Free Capacity in GKC, which should lead to future sales and cash inflows.

In economic conditions that do not sell, it is not impossible to measure the Kaizen effects even if production capacity is increased by Kaizen. But those Kaizen effects can help create more possibilities for a better future.

5. ACTION RESEARCH ON YABASHI HOLDINGS CO., LTD.

After examining the theories surrounding the GKC concept, we collaborated with several Japanese manufacturing companies. We have been working with Yabashi Holdings Co., Ltd., since the fall of 2019 (Hiiragi & Dinh, 2022). More specifically, the target site of our action research is Yabashi Forestry Co., Ltd., a subsidiary of Yabashi Holdings Co., Ltd. It is a factory involved in the timber and steel business that manufactures pre-cut wood, required for assembling private wooden houses. In this section, we introduce the lean journey of Yabashi Holdings Co., Ltd.

5.1 Management issue

In an interview for Newsweek’s December 2021 issue, President Tatsuyoshi Yabashi of Yabashi Holdings Co., Ltd. explained his belief that a company should value its employees. The most important thing for the company, according to President Yabashi, is to “find good human resources and educate and train them in an environment in which

they can experience satisfaction and motivation” (Newsweek’s December 2021). Yabashi Holdings Co., Ltd. is a small and medium-sized manufacturing company located in Ogaki City, Gifu Prefecture, Japan. Yabashi Group is a group of 16 human exploring corporations consisting of nine companies in Japan and seven companies abroad.

Yabashi Forestry Co., Ltd. is a subsidiary within the corporation that manufactures pre-cut lumber for the construction of manufacturing plants (Figure 8). GKC was applied in a project executed by this subsidiary company.



Figure 8 – Yabashi Forestry Co., Ltd. manufacturing pre-cut lumber for construction
Source: Yabashi Holdings Co., Ltd. Hp

5.2 Cost Project

In the fall of 2019, one of the authors was asked by President Yabashi for support in solving the company’s problems. His issue was that the “cost visualization system” is not sufficient, and is difficult to manage when an abnormality occurs. One of the authors of this study proposed that, “it is necessary to visualize the ‘flow’ of the company including the Gemba, identify issues, and apply Kaizen.” Moreover, a proposal was also made to promote the visualization of accounting in parallel with Kaizen activities. The “Cost Project” was thus established with the concept “Re-construction of Yabashi-style cost management.” Figure 9 shows the project policies formulated during the activity’s kick-off.



Figure 9 – Kick-off of Yabashi “Cost Project”
Source: Yabashi Holdings Co. Ltd.

The factory staff have been enthusiastic about Kaizen activities for a long time. Since 2020, they have been developing “Gemba Improvement Project” under the guidance of OJT Solutions, a consolidated subsidiary of Toyota Motor Corporation. For the “Accounting Visualization Project”, two accounting researchers, in addition to the authors, also participated in some of the accounting research activities.

In Phase 1, a factory value stream map was created under the guidance of OJT Solutions. At the same time, the actual situation of cost control within the company was investigated. Even amid the COVID-19 pandemic in 2020, this project continued despite interruptions. In Phase 2, a “cost table for customer residence” was created using Gemba data. The table summarizes the costs and profits in one row for each customer's residence as soon as one product unit was completed. Based on this table, Gemba managers and accounting staff can have an open exchange of opinions, which means they have created the basic tools for lean companies, which are fully utilized in Phase 3.

One of the Kaizen effects is the “frequent stoppage of cutting machine,” which is the result of many complications. Therefore, the following procedures were carried out based on the concept of Kaizen:

- Improved the jig to ensure the "hit" of the material to the tip of the stopper required for clamp operation.
- Adjusted the angle deviation when adding materials.
- Improved material guide to prevent material from hitting the clamp.
- Matched the level of the transport roller and the slit.

The Kaizen process started in July 2021, and the number of outages began to decrease after August 2021. Since a 30-second stoppage is counted as one stop, there had been 0 stops after February 2022 (Figure 10).



Figure 10 – Frequent stoppage time
Source: Yabashi Holdings Co. Ltd.

The Kaizen effect was calculated using data from the cost table for customer residence. Due to the decrease in frequent stoppage for one year from April 2021 to March 2022, the resulting amount of nearly 50,000 yen per month was calculated. However, again, using the same table, the reduction in direct labor costs was 10 times this amount. This

means that there are other forms of sleeping capacities, but it is assumed that they have been improved through, for example, the reduction of waiting time or non-value-added time.

Before starting the Cost Project, President Yabashi knew that the company had no mechanism to see the costs through. Even when there was an abnormality in the cost, it could not be managed. Now, if the Gemba Improvement Project produces Kaizen results, the Accounting Visualization Project can measure the effects numerically.

6. FINDINGS

In this study, we reviewed past and current accounting challenges through the GKC, which is an accounting method we developed to measure the amount of production capacity increase and opportunity loss creation as a Kaizen effects based on an actual costing process. We aimed to utilize GKC to facilitate the lean journey of an organization from the outset and integrate the foundations of the lean concept in a faithful and detailed manner.

Yabashi Holdings Co., Ltd.'s Cost Project comprises a Gemba Improvement Project centered on Gemba Kaizen activities and an Accounting Visualization Project being promoted in parallel. In the Accounting Visualization Project, a new cost, profit, and loss management tool called the "cost table by customer residence" was developed. A major feature of this tool is that it can calculate the cost and profit by residence based on time data acquired using a tablet for each processing unit at the production site. In addition, this tool makes it possible to measure the Kaizen effects achieved by the Gemba Improvement Project as a monthly financial effect.

7. CONTRIBUTION AND OPEN ISSUES

This research presents GKC as a new accounting theory that supports Kaizen. One of the key concepts of GKC is to create "Free Capacity" through Kaizen, measure it using accounting principles, and utilize it through new innovations. Based on the GKC theory, an action research case on the Yabashi Group was demonstrated. Currently, the Yabashi Group is beginning to pursue the GKC approach with its ongoing Cost Project.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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