ワーキングペーパー

The Gemba Kaizen Costing (GKC) Framework
－Introduction to the Opportunity Loss Concept－

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Traditionally, the Kaizen effect has been recognized first as a cost reduction through cost accounting and then as an increase in operating profit on an income statement. Unfortunately, it is difficult to recognize and measure all Kaizen effects as cost reductions or increases in operating profit. To solve this problem, a "change of mindset" is necessary. In this study, we have discarded the majority view that "Gemba Kaizen reduces costs," and focused on the free capacity created by Gemba Kaizen. The effect of Gemba Kaizen is first considered to be the "creation of free capacity," following this, the Kaizen effect is calculated as an increase in sales, cost reduction, and opportunity loss as a result of the strategic use of this free capacity.

Ⅰ The Concept of Gemba Kaizen Costing

1. Muda as waste and its cost

Eliminating Muda in manufacturing is a key concept of GKC. Muda is the subject of Gemba Kaizen, but neither the term nor its definition is clear, which can be inferred from the fact that the word is expressed in Japanese kanji (Chinese characters), katakana, and hiragana. After considering its many definitions, one of the authors defined Muda as that which "refers to all actions in corporate activities that do not produce customer value and all resources reserved and consumed for them" (Hiiragi [2021], p. 66). Similarly, based on the viewpoint of Mr. Taichi Ohno of Toyota Motor Corporation (Ohno [1978]), this book[1] defines Muda as an action that does not create customer value in corporate activities.

Gemba Kaizen is the elimination of Muda, which occurs when manufacturing firms do not convert all input management resources in a production system

into good products. In corporate activities, management resources are consumed along with each action. Although Muda is an action that does not create customer value, it still consumes management resources. The cost of Muda can be calculated by measuring these wasted management resources in monetary terms. Cost accounting generally prioritizes calculating the cost of products produced by actions that add customer value, but it is not used to calculate Muda (waste) costs. In this book, which advocates Gemba Kaizen Costing (GKC), a new accounting theory that contributes to Gemba Kaizen, the cost of Muda is considered an important cost concept (Chapter 5 will detail).

2. Production system and Muda

While respecting the Muda concept presented by Mr. Ohno, which classifies workers' movements into three categories (waste, non-value-added work, and real work), we would like to develop the GKC based on the definition that Muda does not create customer value in corporate activities. Muda is the original "waste" from a worker's movement, and "non-value-added work" is also conditional waste (i.e., work that is originally considered waste, but must be done under the current conditions). It is only "real work" that contributes to the production of a product.

Management resources such as raw materials, labor, machinery and equipment, energy, and information, are usually input into a production system. When converting these management resources into products, good products (finished products) are produced. **Figure 4-1** shows a conceptual diagram of the production system in this book.

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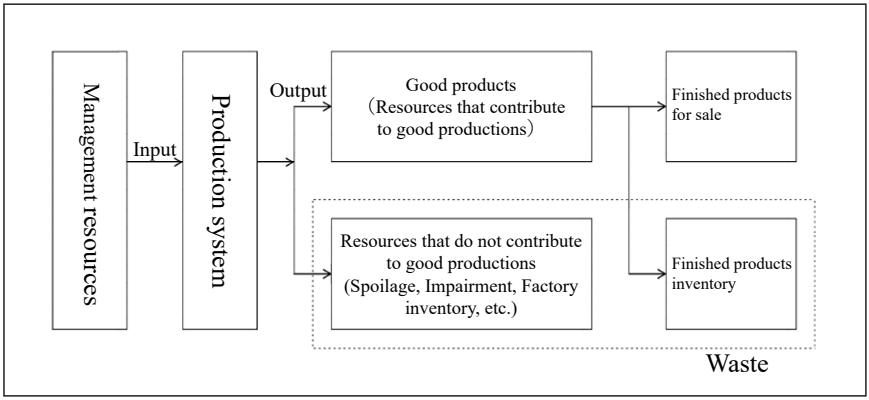
1) 本稿は，刊行予定の上總康行・柊紫乃「現場改善会計論：改善効果の見える化（仮題）」の第4章の英訳版である。書籍は第1章から第6章で構成され，そのうち第4章では従来の製品原価計算とは異なる新たな改善のための計算構造が提唱される。海外の会計研究者との議論のため，日本語版刊行前に当該章の英訳をワーキング・ペーパーとして公表する。
This paper is an English translation of Chapter 4 of "Gemba Kaizen Costing: Visualization of Kaizen Effect (tentative title)" by Kazusa Yasuyuki and Hiiragi Shino, which is scheduled for publication. The book consists of Chapters 1 through 6, of which Chapter 4 proposes a new costing structure for Kaizen that differs from conventional product costing. The English translation of this chapter is published as a working paper before the publication of the book for the purpose of discussion with overseas accounting researchers.

Figure 4-1 Conceptual diagram of the production system



Source: Author

According to **Figure 4-1**, the management resources that contribute to the production of good products are "value-added resources," while those that do not are "non-value-added resources." Non-value-added resources include product loss, impairment, waiting time, and "factory inventory," such as raw materials, parts, and works-in-process stored in each process, factory, and warehouse. Non-value-added resources and all management resources that do not become sales goods (the area enclosed by the dotted line) are Muda. The relationship between the management resources input into the production system, the output (good product), and the Muda that did not become a good product can be expressed using the following equation:

$$\begin{aligned}\text{Management resources} &= \text{Value-added resources} + \text{Non-value-added resources} \\ &= \text{Sold products} + \text{Muda}\end{aligned}$$

According to the above equation, management resources are transformed through the production system into sold goods delivered to customers and Muda. Muda further includes unsold product inventories, factory inventories of raw materials, parts, and works-in-process, as well as the

impairments and process losses that occur in the production process, the idle time of workers, and idle machinery and equipment. Unsold product inventories are considered Muda because they do not create customer value. There are different types of Muda, resulting from a variety of factors. For manufacturers, the elimination of Muda is an "eternal challenge" that Gemba Kaizen tries to address.

Ⅱ Creating free capacity through Gemba Kaizen

Gemba Kaizen is constantly being practiced at the production site. It eliminates Muda, improves productivity and quality, shortens lead time, and realizes flexibility. Traditionally, these Gemba Kaizen effects have been recognized in cost accounting terms as "cost reductions," and as increases in operating income on the income statement. Unfortunately, it is difficult to recognize all Gemba Kaizen effects as cost reductions or increases in operating profit. While practitioners and researchers have been working for years to solve the problem of measuring the Gemba Kaizen effects, a "change in mindset" is the likely solution.

As a first step in solving the aforementioned problem, we decided to go back to the simple question of "Why does the Gemba Kaizen effect lower costs?" We concluded that Gemba Kaizen does not simply lower costs over time as there are cases where costs do not decrease due to Kaizen.

Different from the general theory that recognizes the Gemba Kaizen effect as a cost reduction or increase in operating profit, we introduce the concept of "free capacity." First, we see the effect of Gemba Kaizen as the "creation of free capacity." Next, based on the free capacity created, the cost reduction or opportunity loss, which is the Gemba Kaizen effect for accounting purposes, is calculated.

[Example 1] illustrates the creation of free capacity using simple production data before and after Kaizen as follows:

[Example 1] Production data

Before Kaizen

Input management resources: Raw material 100 kg, Work time 10 hours

Product: Good products 60 kg, Impairment 40 kg

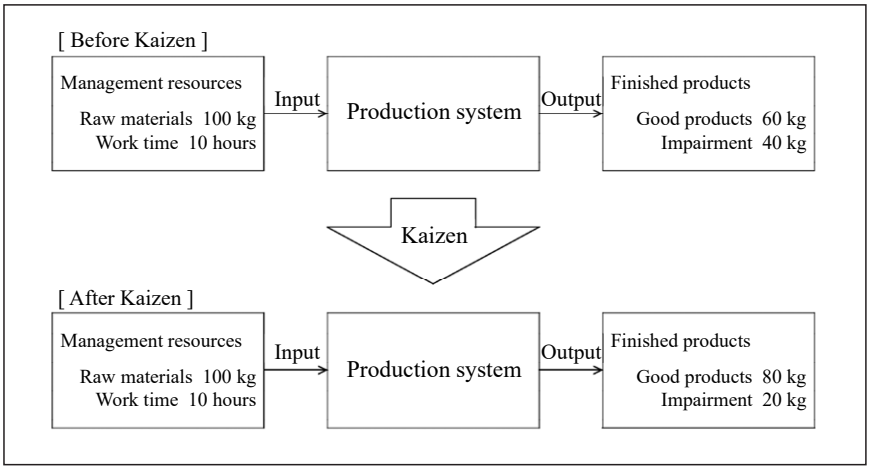
After Kaizen

Input management resources: Raw material 100 kg, Work time 10 hours

Product: Good products 80 kg, Impairment 20 kg

Figure 4-2 further illustrates the production data before and after Kaizen.

Figure 4-2 Production data before/after Kaizen



Source: Author

Before Kaizen, 100 kg of raw material and 10 hours of work were input into the production system, producing 60 kg of good products. After Kaizen, the same 100 kg of raw material and 10 hours of work were input, resulting in an improved yield rate and production of 80 kg of good products. Assuming a regular work time of 8 hours per day and 25 operating days per month, we now discuss the calculation of the free capacity created by practicing Kaizen.

Production capacity refers to the capacity of a production system to produce products. Free capacity is when production capacity is increased through Gemba Kaizen. This book uses labor productivity to represent the productivity of the production system, as shown in the following equation:

Labor productivity = Output/Production hours
= (Output/Input) × (Input/Production hours*)
= Koritsu[2] × Noritsu

*Product time, however, is used for human work time or machine processing time, depending on the situation.

"Koritsu" in the above equation is the "ratio of output to input," and "Noritsu" is "the level of ability to perform tasks in a specified time" (Hitomi [2017], p. 17). The concept of koritsu can be viewed through the lens of the more commonly used term "physical (material) productivity." The concept of noritsu was expressed in the early 1900s with the word efficiency. "An industrial engineering pioneer, H. Emerson discussed this and established 12 principles in 1916" (Hitomi [1996], p.22). By his definition, efficiency is calculated by dividing standard time by actual time. However, it is calculated in terms of input per hour in the above formula. An increase in the ratio of standard time to actual time means that the actual time used for the same amount of input becomes shorter. In this sense, these two divisions express the same efficiency. We define the latter formula as noritsu.

Gemba Kaizen is involved in both koritsu and noritsu, and contributes to labor productivity through the practice of Kaizen. Since labor productivity is expressed in terms of "output per hour," monthly output is calculated by multiplying the quantity by the number of hours worked per month, which indicates monthly production capacity.

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2) Koritsu and noritsu are two different words in Japanese, but both translate directly into "efficiency" in English. "The English word "efficiency" is used in quantitative expressions for both koritsu and noritsu, while "effectiveness" carries a qualitative meaning together with koritsu, such as efficacy or effectiveness" (Hitomi [2017], p.17, footnote).

Let us now calculate the monthly production capacity [before Kaizen] . First, we assume that koritsu is 100%, then calculate the expected monthly production capacity. Considering the yield ratio, let us calculate the actual monthly production capacity:

Monthly expected production capacity
= Production volume per hour × Daily working hours
×Number of operating days
= (Production volume/Work time) × Daily working hours
× Number of operating days
= (100 kg/10 hours) × 8 hours × 25 days
= 2,000 kg/month
Monthly actual production capacity
= (Quantity of good products/Work time) × Daily working hours
× Number of operating days
= (60 kg/10 hours) × 8 hours × 25 days
= 1,200 kg/month
Koritsu loss = Expected monthly production capacity
– Actual monthly production capacity
= 2,000 kg/month – 1,200 kg/month
= 800 kg/month

With a 100% yield rate [before Kaizen] , the expected monthly production capacity in the above equation is 2,000 kg/month. However, the actual monthly production capacity decreased to 1,200 kg/month due to koritsu loss caused by the poor conversion rate of input management resources to good products. The resulting koritsu loss is 800 kg/month. Next, let us calculate the production capacity [after Kaizen].

Monthly expected production capacity

= (Production volume/Work time) × Daily working hours
× Number of operating days

= (100 kg/10 hours) × 8 hours × 25days

= 2,000 kg/month

Monthly actual production capacity

= (Quantity of good products/Work time) × Daily working hours
× Number of operating days

= (80 kg/10 hours) × 8 hours × 25 days

= 1,600 kg/month

Koritsu loss = Expected monthly production capacity
– Actual monthly production capacity

= 2,000 kg/month – 1,600 kg/month

= 400 kg/month

[After Kaizen], the expected monthly production capacity in the above equation is 2,000 kg/month when the yield rate is 100%, and the actual monthly production capacity is 1,600 kg/month. Koritsu losses decreased to 400 kg/month. The free capacity created by Gemba Kaizen can be calculated as follows:

Kaizen of koritsu loss = 800 kg/month – 400 kg/month = 400 kg/month

Free capacity = Koritsu loss improvement

= 400 kg/month

or

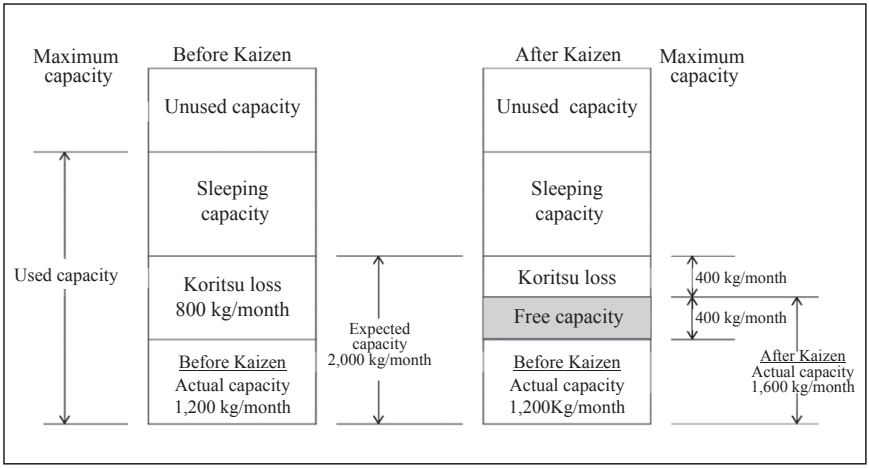
Free capacity = Actual monthly production capacity after Kaizen
– Actual monthly production capacity before Kaizen

= 1,600 kg/month – 1,200 kg/month

= 400 kg/month

Thus, the free capacity created by Gemba Kaizen can be calculated as 400 kg/month. **Figure 4-3** illustrates the creation of free capacity by Gemba Kaizen.

Figure 4-3 Creation of free capacity through koritsu improvements



Source: Author

Figure 4-3 illustrates the production capacity before and after Kaizen. In a factory production system, the theoretical maximum production capacity is usually set. When the production system (factory) is operational, various factors combine to produce at a level below the maximum production capacity—this is called actual production capacity. The difference between maximum and actual production capacity includes unused capacity resulting from machine breakdowns and supply-demand gaps, or sleeping capacity resulting from various Muda and non-value-added operations. These production capacities are discussed in detail in Chapter 6.

Figure 4-3 shows the actual production capacity of 1,200 kg/month before Kaizen and 1,600 kg/month after Kaizen. The Gemba Kaizen effect on "koritsu loss 800 kg/month" created 400 kg/month of free capacity as a result of the decreace in koritsu losses, which is represented by the shaded box.

[Example 1] on page 20 illustrates the free capacity resulting from Gemba Kaizen, which aims to reduce koritsu losses. [Example 2] below presents the case where koritsu and noritsu losses are simultaneously improved.

[Example 2] Production Data

Before Kaizen

Input management resources: Raw material 100 kg, Work time 10 hours

Product: Good products 60 kg, Impairment 40 kg

After Kaizen

Input management resources: Raw material 100 kg, Work time 8 hours

Product: Good products 80 kg, Impairment 20 kg

The calculation in [Example 1] provides an example of improving koritsu loss. In [Example 2], both koritsu and noritsu losses improved and work time was reduced from 10 hours before Kaizen to 8 hours after. This reduction of two hours is a major contribution to Kaizen at noritsu loss.

Assuming that the daily work time of the production system is 8 hours, and there are 25 operating days per month, we calculate the free capacity based on the production data in [Example 2]. Since the conditions other than noritsu loss reduction are the same as in [Example 1], only the calculation results are shown here.

Monthly expected production capacity = 2,000 kg/month

Monthly actual production capacity = 1,200 kg/month

Koritsu loss =800 kg/month

Next, let us calculate the production capacity [after Kaizen].

Monthly expected production capacity

= (Production volume/Work time) × Daily working hours
× Number of operating days

= (100 kg/8hours) × 8 hours × 25 days

= 2,500 kg/month

Monthly actual production capacity

= (Quantity of good products/Work time) × Daily working hours
× Number of operating days

= (80 kg/8 hours) × 8 hours × 25 days

= 2,000 kg/month

Koritsu loss = Expected monthly production capacity
– Actual monthly production capacity

= 2,500 kg/month – 2,000 kg/month

= 500 kg/month

[After Kaizen], the expected monthly production capacity in the above equation is 2,500 kg/month. This is because the work time for the same 100 kg input was reduced from 10 to 8 hours. In other words, Gemba Kaizen improved noritsu and reduced noritsu losses. The actual monthly production capacity after Kaizen is 2,000 kg/month. As a result, koritsu losses were reduced to 500 kg/month. The free capacity created by Gemba Kaizen can be calculated as follows:

Kaizen of noritsu loss

= Expected monthly production capacity after Kaizen
– Expected monthly production capacity before Kaizen

= 2,500 kg/month – 2,000 kg/month

= 500 kg/month

Kaizen of koritsu loss

= Koritsu loss after Kaizen – Koritsu loss before Kaizen

= 800 kg/month – 500 kg/month

= 300 kg/month

Free capacity

= Kaizen of noritsu loss + Kaizen of koritsu loss

= 500 kg/month + 300 kg/month

=800 kg/month

or

Free capacity

= Actual monthly production capacity after Kaizen

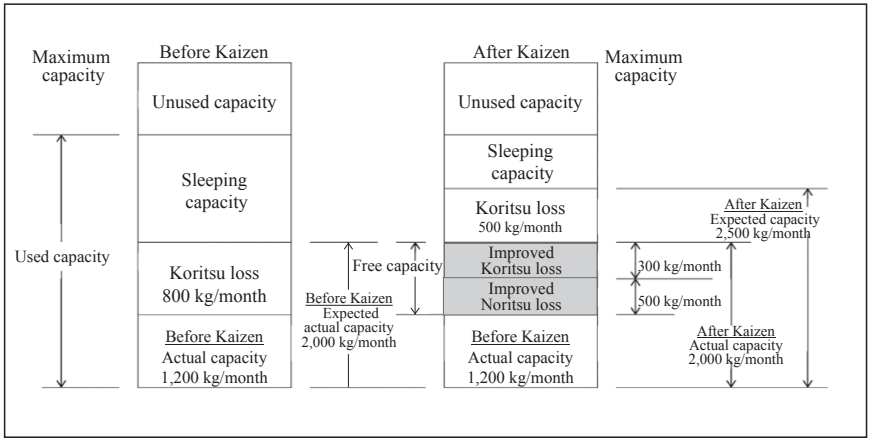
– Actual monthly production capacity before Kaizen

= 2,000 kg/month – 1,200 kg/month

= 800 kg/month

Thus, the free capacity created by Gemba Kaizen can be calculated as 800 kg/month. **Figure 4-4** illustrates the creation of free capacity by Gemba Kaizen [Example 2].

Figure 4-4 Creation of free capacity through koritsu and noritsu improvements



Source: Author

Figure 4-4 illustrates the production capacity before and after Kaizen, assuming that Gemba Kaizen was implemented to improve koritsu and

noritsu, simultaneously. As shown in the formula, the free capacity of 800 kg/month created by Kaizen is calculated by subtracting the actual production capacity of 1,200 kg/month before Kaizen from the actual production capacity of 2,000 kg/month after Kaizen. The created free capacity is "shaded." The free capacity created amounted to 800 kg/month, which is the sum of the Kaizen of koritsu loss at 300 kg/month and the Kaizen of noritsu loss at 500 kg/month.

In the case of [Example 1], the expected production capacity with a yield ratio of 100% is 2,000 kg/month, the same value before and after Kaizen. For this reason, improving the yield ratio is the key to the Kaizen of koritsu loss. In [Example 2], the Kaizen of noritsu loss is added to Kaizen of koritsu loss. Kaizen by noritsu loss reduces work time, so the expected production capacity after Kaizen increases. In this case, shortening the work time becomes the decisive factor. Applying the Kaizen approach to noritsu loss means reducing the sleeping production capacity. Sleeping capacity can be replaced by the invisible Muda of noritsu, which Kaizen reveals.

Free capacity is "created" by Gemba Kaizen through the elimination of Muda and the reduction of non-value-added activities. The Muda of production capacity resulting from machine breakdowns or gaps in supply and demand is generally referred to as "idle capacity." However, free capacity, which we advocate, could also be confused with idle capacity even if the two are completely different. Therefore, instead of idle capacity, this book uses the term "unused capacity" for a clearer distinction. Further, we deliberately refer to the created but currently unused production capacity as free capacity rather than idle capacity.

Ⅲ Visualization of Kaizen effect through the concept of opportunity loss

This book highlights opportunity loss as an important concept in GKC. According to Prof. Norio Sawabe (Kyoto University), a concept similar to

opportunity loss is opportunity cost. After reviewing numerous domestic and foreign management accounting texts, Prof. Sawabe states that "a relatively common understanding of the concept has been established" (Sawabe [2016], p. 180).

Prof. Kiyoshi Okamoto (Hitotsubashi University) states, "When we make a decision to use some scarce resource for a specific purpose, we must give up the benefits that could be obtained from alternative uses of that resource. The maximum amount of profit to be foregone is called opportunity cost" (Okamoto [2000], p. 12). Prof. Michiharu Sakurai (Senshu University) stated that opportunity cost is "the profit that is foregone due to the execution of a certain management objective" and then stated, "For example, if Proposal A is adopted, a profit of 2 billion yen is expected; and if proposal B is adopted, a profit of 3 billion yen is expected, although the risk is higher than that for Proposal A. If management adopts proposal A, the 3 billion yen of abandoned Proposal B becomes opportunity cost" (Sakurai [2019], p. 104).

With regard to the opportunity loss concept, "it is understood diversely and no unified definition is shared. Even looking at recently published texts in Japan, the terminology is diverse" (Sawabe [2016] , p. 180) . After considering the view that opportunity loss is synonymous with opportunity cost, the view that opportunity loss and lost profit are synonymous, and the view that opportunity loss and opportunity profit are "the difference between opportunity cost and opportunity profit," Prof. Sawabe presented the following formula as a practical "opportunity loss and opportunity profit" concept (Sawabe [2016], p. 180):

Opportunity loss
or = Opportunity revenue – Opportunity cost
Opportunity profit

In the above equation, opportunity cost is the "profit that would have been obtained by the alternative being abandoned" because an alternative was

chosen, and opportunity revenue is the "profit obtained from the alternative chosen" (Sawabe [2016], p. 180).

Prof. Yoshihiro Ito (Waseda University) holds the same opinion as Prof. Sawabe, and states that "opportunity cost is only measured to evaluate the superiority or inferiority between alternatives," while "opportunity loss can be defined as the loss that occurs when an alternative more favorable than the adopted alternative exists but is not adopted" (Ito [2013], p. 353). In this case, if the choice is made to abandon a favorable alternative, the benefits that would otherwise have been gained are lost.

Mr. Ryo Igarashi, who has been active as a management consultant in the field of production management, shares the same view as Prof. Ito.

> Opportunity loss refers to the loss of a chance that should have been adopted but was not. To explain this more clearly, let us assume that a person has 10 million yen and puts it in a bank savings account to earn interest. If this interest rate is 3% per year, after one year, a profit of 300,000 yen will be generated. However, if this person had put the money in a one-year time deposit instead of a savings account, he would have earned 700,000 yen as 7% interest per year, resulting in a loss of 400,000 yen by difference. In other words, the opportunity loss in this case is the ¥400,000 that was lost because the investor had a chance to enter the time deposit but did not. (Igarashi [2009], p. 4)

According to these views, in Gemba Kaizen, if the decision is made to "leave" the free capacity, the benefit that would have been gained is lost because the alternative of "using" it is abandoned. Based on these considerations, this book uses the concept of opportunity loss to mean "profit that would have been gained but was lost if free capacity were left as is."

With this understanding, we present a simple example of opportunity cost and opportunity loss, assuming the evaluation and selection of the Gemba Kaizen alternative. In Proposal A, the free capacity created from the Kaizen

effect can be used for additional production to earn a profit of 1 million yen. Proposal B leaves nothing undone. In other words, the profit is zero. Let us assume that management adopts Plan B, which is to do nothing (leave free capacity), from the two alternatives.

Opportunity cost concept

Opportunity Cost = Profit of Proposal A 1,000,000 yen

Opportunity loss concept

Opportunity loss = Profit of Proposal A 1,000,000 yen
– Profit of Proposal B 0 million yen
= 1,000,000 yen

Both results for opportunity loss and opportunity cost in the above example amount to 1,000,000 yen. If the free capacity created from the Kaizen results is not utilized, the opportunity to earn a profit of 1,000,000 yen is lost, regardless of whether the opportunity cost or opportunity loss concept is used in the calculation. However, if the benefit from the alternative that takes advantage of the Kaizen effect is not zero or if there are more than three alternatives, the calculation results will be different. Since selecting the best among many alternatives is also necessary to take advantage of the Kaizen effect, in this book, we adopt the opportunity loss concept, which allows us to calculate the difference in benefits among alternatives.

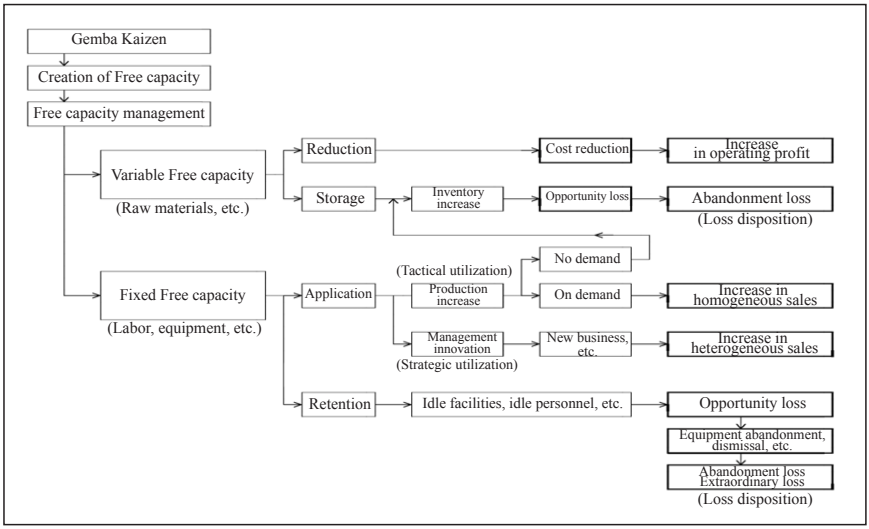
Ⅳ Free capacity management

In this book, we focus on the free capacity created by Gemba Kaizen in contrast to the majority view, which recognizes cost reductions and an increase in operating profit as Gemba Kaizen effects. This book has so far collectively referred to the four elements of the Kaizen effect (productivity improvement, lead-time reduction, quality improvement, and flexibility realization) as free capacity creation. Based on the free capacity created, we

then explained in detail the procedures for calculating cost reductions and opportunity losses as accounting for Gemba Kaizen effects. Nevertheless, these cost reductions and opportunity losses are the result of the management and utilization of the free capacity created. So, let us consider the management of free capacity again in detail.

Management resources are input into the production system to form production capacity, which Gemba Kaizen increases. Increased management resources are called "free capacity." Free capacity can be classified into two categories based on its characteristics. One is "variable free capacity," in which the factors of production under free capacity can be removed from the current production system. It typically corresponds to raw materials and has the nature of variable productive capacity. The other is "fixed free capacity" in which the factors of production that form the basis of free capacity cannot be removed from the production system. Typically, regular employees (regular labor) or machines are in the nature of fixed productive capacity. With this understanding, **Figure 4-5** illustrates the management of excess production capacity.

Figure 4-5 Free capacity management



Source: Author

As shown in the upper left corner of **Figure 4-9**, free capacity is created by Gemba Kaizen and managed. Management methods can be broadly classified into two categories depending on the nature of the free capacity:

①"Reduction" and "storage" are performed for variability free capacity. During reduction, management resources such as raw materials are reduced and cost reduction is realized. As a result, operating profit increases. During storage, input resources such as raw materials are stored in a warehouse for a short or long period. As a result, stored inventory increases and, if stored for a long period, may be disposed of due to factors such as economic obsolescence and changes in design specifications. Stored inventory that is disposed of is treated as disposal losses, and the cost reductions that were supposed to be realized by Gemba Kaizen become a pipe dream.

②For fixed free capacity, "application" and "retention" are implemented. Application means actively utilizing the free capacity created by Gemba Kaizen. There are two ways to utilize the system: "production increase" and "management innovation." Production increase is a tactic that means to produce the same or similar products, utilizing the free capacity as it is. In the case of "on demand" conditions, sales increase and, consequently, operating profit also increases. Production increase requires no additional costs other than variable ones, so a large operating profit can be expected. However, under "no demand" conditions, production increase will only increase product inventories and, in some cases, lead to disposal losses in the future.

Furthermore, regarding management innovation, the strategic use of free capacity is important, where management resources such as machinery and employees are effectively utilized for research and development, new product development, new customer development, and the development of new strategies. As a result, "heterogeneous sales" are

realized by launching new products that are different from conventional ones, developing new businesses, and so on. Management innovation gives companies an advantage in global competition.

"Retention" means that the free capacity created by Gemba Kaizen is retained or unwillingly ignored. When production facilities and human resources (e.g., employees) remain unused, a state of "Mottainai (waste)" occurs. From an accounting point of view, this situation means that opportunity loss occurs in the sense that the company loses profits it could have earned if it had used the management resources effectively. After which, if free capacity remains unused, the machine may be reluctantly scrapped and employees may be laid off due to management decisions. As a result, there will be large disposal and extraordinary losses, and the practice of Gemba Kaizen would have been for nothing.

Most accounting evaluations of the Gemba Kaizen effect have focused on cost reduction. However, cost reduction is merely the result of the reduction of input resources, which is one of the four methods of free capacity management (reduction, storage, application, and retention). We posit that more focus should thus be actively paid to the method of application, or the tactical use of free capacity, such as production increase, and strategic use such as management innovation.

Ⅴ Calculating cost reduction in direct material cost

The economic effect of Gemba Kaizen is generally calculated by comparing the product cost before and after Kaizen, focusing on the reduction of management resources by Kaizen. The cost reduction is shown by the following equation:

Cost reduction = Product cost before Kaizen – Product cost after Kaizen

However,

Product cost = Total input of management resources/Quantity of good products

Quantity of good products = Quantity of produced products
- Quantity of defective products
- Quantity of offcuts in terms of the quantity of finished products

The actual product cost before and after Gemba Kaizen is compared to calculate the cost reduction, which is used as the cost improvement effect. The smaller the product cost after Kaizen, the larger the cost reduction. If the total input of management resources is the same before and after Kaizen, the larger the quantity of good products, the smaller the cost of products. To increase the quantity of good products, the quantity of produced products must also be increased and the quantity of offcuts must be reduced in terms of the quantity of finished products. Furthermore, the quantity of defective products must also be reduced. To reduce the number of offcuts and the number of defective products, the yield ratio must be improved and defective products eliminated—these are the main targets of Gemba Kaizen.

The extent of cost reduction can be calculated for each product and process. Both the product cost and its components, such as direct material cost, direct labor cost, and manufacturing overhead cost, can be subject to calculation. For example, the actual cost of direct material costs before and after Kaizen can be compared to calculate the effect of Gemba Kaizen, as shown in [Example 3].

[Example 3]

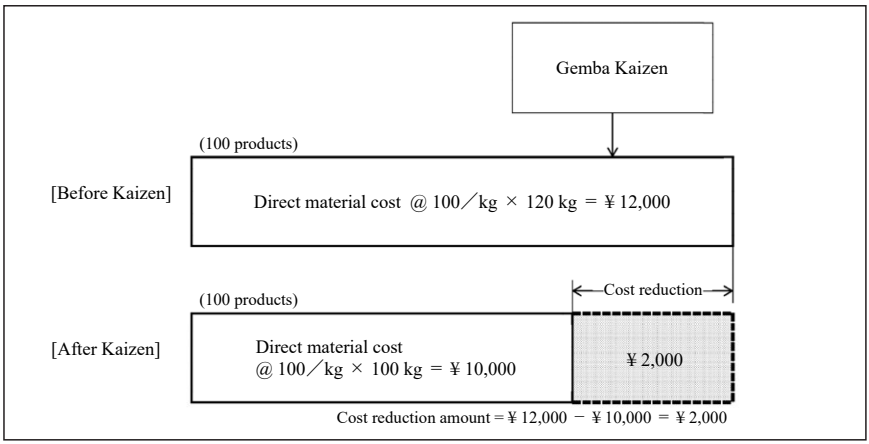
Suppose there is a production Gemba that produces 100 units of a product by inputting 120 kg of steel at 100 yen per kg. Gemba Kaizen has improved productivity so that only 100 kg of steel is needed to produce 100 units of the same product.

Under this condition, the cost reduction in direct material cost can be calculated as follows:

Before Kaizen: Steel 100 yen/kg × 120kg = 12,000 yen (100 units)
After Kaizen: Steel 100 yen/kg × 100kg = 10,000 yen (100 units)
Cost difference = 12,000 yen before Kaizen – 10,000 yen after Kaizen
= 2,000 yen (cost reduction)

The difference of 2,000 yen in cost before and after Kaizen is the reduction of Muda by Gemba Kaizen, which is the amount of cost reduction. This cost reduction of 2,000 yen is a result of the Kaizen effect in accounting. **Figure 4-6** illustrates the Kaizen effect of direct material costs.

Figure 4-6 Cost improvement in direct material costs



Source: Author

Figure 4-6 shows that the Kaizen effect of Gemba Kaizen is calculated as a cost reduction of 2,000 yen. Certainly, cost accounting allows us to calculate the Kaizen effect of Gemba Kaizen as a cost reduction amount.

However, in calculating the cost reduction, it is assumed that Gemba Kaizen reduces the required usage, resulting in a surplus of raw materials, which are returned to the supplier. If that happens, the cash outflow equal to the cost reduction is reduced. Many practitioners and researchers seem oblivious to this critical assumption. Because the extra raw material is used

in the next manufacturing order under conventional low-volume production, there is no need to purchase additional raw material for that amount of material. Therefore, the excess raw materials from Gemba Kaizen are offset by the reduced purchases, resulting in a lower cash outlay and lower costs. Such "offsetting" is automatic under small-mix, high-volume production; thus, there is no need to worry about excess raw materials. However, this assumption does not always hold under lot production, make-to-order production, or even high-mix low-volume production.

If this assumption does not hold, then the raw material surplus by Gemba Kaizen is transferred from the production Gemba to the warehouse, where it is stored temporarily or even involuntarily for a long period. Disposal would be the worst-case scenario. Since the excess raw materials were stored in warehouses, it cannot be said that costs have been reduced.

As pointed out in **Figure 4-2**, we define all inventories as Muda, including factory and product inventories, such as raw materials and process inventories. Not only is inventory, such as raw materials and product stock stored in warehouses, not immediately convertible to cash, but it also bears the risk of disposal. Therefore, it must be recognized as Muda.

Ⅵ Amount of Kaizen effect in direct labor cost

Next, let us examine the Kaizen effect of direct labor costs. The amount of Gemba Kaizen effect can be calculated by comparing the actual cost of direct labor before and after Kaizen. [Example 4] and [Example 5] illustrate the first and second Kaizen, respectively, under [basic conditions].

[Basic conditions]

Suppose that in Gemba production, where the hourly wage rate is 2,000 yen per hour and workers work 8 hours per day (regular hours), the direct work time for processing a certain product is 10 hours. Since the product processing is not completed on time, 2 hours of overtime work is required at a premium

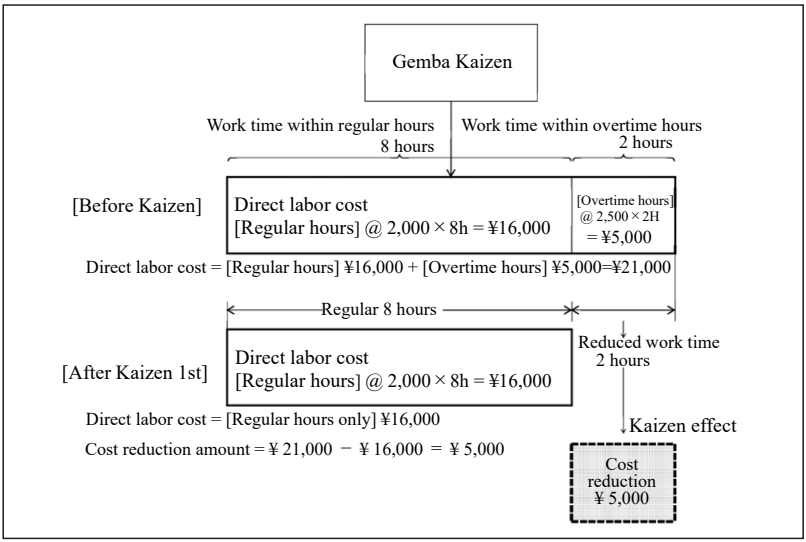
rate of 25% (overtime pay). Under these conditions, Gemba Kaizen was performed in two stages. The first and second Kaizen are explained below.

1 1st Kaizen

[Example 4]

Suppose that the first Kaizen is performed and the direct time required to process a product is reduced from 10 to 8 hours. **Figure 4-7** illustrates the case of work time reduction (elimination of overtime) by Gemba Kaizen.

Figure 4-7 Reduction of work hours by Gemba Kaizen (Elimination of overtime work hours)



Source: Author

According to **Figure 4-7**, the direct labor costs before and after Kaizen can be calculated as follows:

Before Kaizen:

Regular hours wage rate @ 2,000 yen/hour × 8 hours

= 16,000 yen

Overtime hours wage rate @ 2,500 yen/hour × 2 hours = 5,000 yen

Direct labor cost = Regular hours + Overtime hours
= 16,000 yen + 5,000 yen
= 21,000 yen

After Kaizen:

Direct labor cost = Regular hours wage rate @ 2,000 yen/hour × 8 hours
= 16,000 yen

Cost reduction = 21,000 yen before Kaizen – 16,000 yen after Kaizen
= 5,000 yen (favorable variance)

As a result of comparing direct labor costs before and after Kaizen, a favorable variance of 5,000 yen is calculated as a cost variance. Gemba Kaizen saved 2 hours of work, with a corresponding reduction in direct labor costs. Since the overtime allowance (hourly wage) is a variable cost, the cost was reduced by 2 hours of overtime allowance @ 2,500 yen/hour × 2 hours = 5,000 yen. The effect of the first Kaizen is a cost reduction of 5,000 yen in direct labor costs.

2 2nd Kaizen

[Example 5]

Next, if the 2nd Kaizen is performed and the 8 hours of direct labor time for processing the product is further reduced to 6 hours, the direct labor cost can be calculated as follows:

Before Kaizen:

Regular hours wage rate @ 2,000 yen/hour × 8 hours = 16,000 yen

After Kaizen:

Regular hours wage rate @ 2,000 yen/hour × 6 hours = 12,000 yen

Cost reduction = 16,000 yen before Kaizen – 12,000 yen after Kaizen
= 4,000 yen (favorable variance)

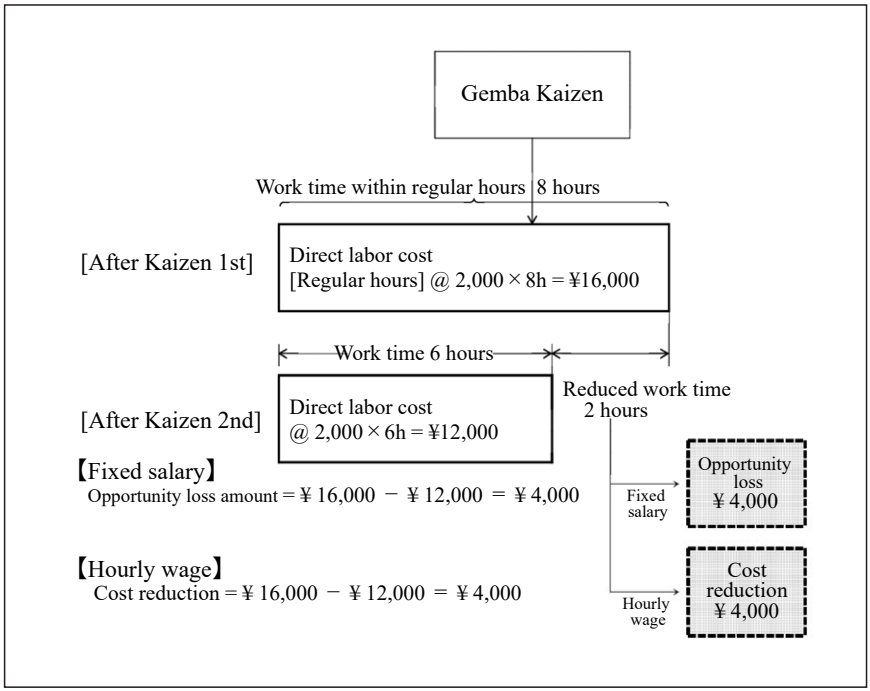
The cost difference of 4,000 yen between the periods before and after Kaizen was applied is the cost reduction of 4,000 yen by the 2nd Kaizen if it is a variable cost, such as overtime allowance. However, most Japanese companies employ their workers on a long-term or lifetime employment basis, and direct workers who are hired as regular employees are paid a fixed salary. On this basis, one of the authors argues that:

> Let us say that a product that now takes 5 hours to produce can now be produced in 2 hours and 30 minutes—half the time it used to take. Simply put, the cost of labor should be halved. But that is only if the payment of the shortened 2 hours and 30 minutes of wages can be cut off. If the company is fully hourly, this is possible, but if piece-rate or monthly wages are applied, the increase in speed does not directly lead to a reduction in the cost of the product. …… Even if work time is cut in half, if the wage payment is not cut to compensate, then it will be as if Kaizen were never applied. Labor cost differences do not arise at all (Kazusa [2000], p.1157).

Here, it is emphasized that when fixed wages are paid to direct workers in employment contracts, no matter how much work time is reduced, labor costs are not reduced unless the corresponding wage payment is cut.

In the 2nd Kaizen, if the work time is reduced but the salary is paid as a fixed cost, the Kaizen effect of reduced work time is not measured as a cost reduction of 4,000 yen. Of course, in the case of hourly workers, such as non-regular employees, there is no need to pay wages for the shortened work hours, so the Kaizen effect can be measured as a cost reduction of 4,000 yen. Nevertheless, even an immediate reduction in the wages of non-regular employees is difficult in reality. In short, people may not be motivated to engage in Kaizen if they know that their wages will be reduced in the first place. This is one of the challenges that come with adopting Gemba Kaizen. **Figure 4-8** illustrates the case of work time reduction (regular hours) by Gemba Kaizen.

Figure 4-8 Reduction of work hours by Gemba Kaizen
(Elimination of regular work hours)



Source: Author

Figure 4-8 shows that after the 1st Kaizen, the direct labor cost is 16,000 yen. In the 2nd Kaizen, work time is further shortened by 2 to 6 hours. As a result, the direct labor cost after the 2nd Kaizen is at 2,000 yen/hour × 6 hours = 12,000 yen. The Kaizen effect amount of direct labor cost by the 2nd Kaizen is calculated as 16,000 yen – 12,000 yen = 4,000 yen.

The 2nd Kaizen reduces the regular working hours by 2 hours, but the reduction in hours does not unconditionally lead to a reduction in labor costs. The question of what kind of calculation should be done thus remains unanswered. We believe that by introducing the opportunity loss concept, the Kaizen effect amount can be calculated even when salaries are paid as a fixed cost.

Even if Kaizen can shorten the number of work hours, under the

manufacturing instructions, which are based on strict adherence to the planned production volume, additional production cannot be performed immediately for the shortened work hours. Therefore, direct workers with fixed wages who could have contributed 2 hours' worth of work are left unutilized. If management resources (human resources) are left unutilized, opportunity loss will occur in terms of lost opportunities to earn profits. Therefore, the Kaizen effect of 4,000 yen, which cannot be measured as a cost reduction, becomes an opportunity loss. According to this approach, if direct laborers are employed at a fixed salary, the Kaizen effect amount for direct labor cost can be organized as follows:

1st Kaizen

Kaizen effect amount = Cost reduction + Opportunity loss amount

= 5,000 yen + 0 yen = 5,000 yen

2nd Kaizen

Kaizen effect amount = 0 yen + 4,000 yen = 4,000 yen

Total amount 9,000 yen

Thus, by applying the opportunity loss concept, the cost reduction amount of 5,000 yen for the 1st Kaizen and the opportunity loss amount of 4,000 yen for the 2nd Kaizen can be calculated. Then, the total effect through the two stages of Kaizen can be calculated at 9,000 yen. GKC will be able to calculate the Kaizen effect amount, which is not visible in normal full costing.

Ⅶ Amount of Kaizen effect in manufacturing overhead cost

The Kaizen effect can be calculated for manufacturing overhead costs using the same approach as for direct labor costs. Since manufacturing overhead costs are a mixture of variable and fixed costs, it is sufficient to break them down into variable and fixed costs and to calculate the Kaizen amount by adding not only the cost reduction amount but also

the opportunity loss amount. Let us calculate the Kaizen effect amount of manufacturing overhead cost according to [Example 6].

[Example 6]

To simplify the discussion, assume that manufacturing overhead is only a fixed cost and not a variable cost. If the monthly fixed budget for manufacturing overhead is 5,000,000 yen/month, working days are 25 days/month, working time is 8 hours/day, and the allocation standard is working time, the scheduled allocation ratio of manufacturing overhead is calculated as follows:

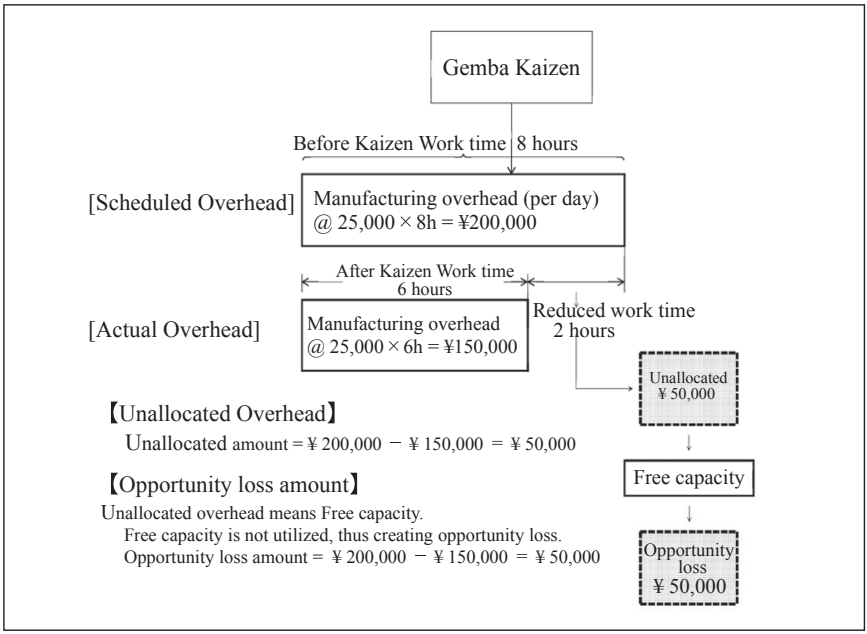
Scheduled allocation rate = Fixed budget amount/Monthly work time
= 5,000,000 yen/(25 days × 8 hours/day)
= 25,000 yen/hour

Before Gemba Kaizen, the direct working time for machining a certain product is 8 hours. Suppose this work time is reduced to 6 hours by Gemba Kaizen. Every mouth, work time has been reduced from 200 to 150 hours. The actual allocated and unallocated amounts of manufacturing overhead can be calculated as follows:

Fixed budgeted amount for manufacturing overhead = 5,000,000 yen
Actual allocated amount of manufacturing overhead
= Scheduled allocation rate × Actual monthly work hours
= @ 25,000 yen/hour × 150 hours
= 3,750,000 yen
Unallocated manufacturing overhead
= Fixed budgeted amount – Actual allocated amount
= 5,000,000 yen – 3,750,000 yen
= 1,250,000 yen

The unallocated amount of 1,250,000 yen of manufacturing overhead is usually calculated as an unfavorable capacity utilization variance. From a different perspective, this capacity utilization difference represents the amount of favorable Kaizen effect generated by Gemba Kaizen. In this case, the calculation of a "favorable" variance, rather than the previously assumed "unfavorable" variance, is particularly important. To emphasize that Gemba Kaizen produces favorable differential effects, we use the term "unallocated amount" instead of "capacity utilization difference" in GKC. The reason the term unallocated amount is used is not merely a matter of words but is related to the essence of Gemba Kaizen. **Figure 4-9** shows the Gemba Kaizen effect of manufacturing overhead costs.

Figure 4-9 Gemba Kaizen effect on manufacturing overhead costs



Source: Author

According to **Figure 4-9**, since Gemba Kaizen shortened the working hours by 2 hours, the actual allocation of manufacturing overhead cost is reduced by that amount, and the effect is calculated to be 25,000 yen/hour × 6 hours = 150,000 yen. As a result, the unallocated amount of manufacturing overhead is calculated as follows:

Unallocated amount = 200,000 yen – 150,000 yen = 50,000 yen

The shortening of the work time caused an unallocated amount of manufacturing overhead, but since it is assumed that manufacturing overhead is a fixed budget, this unallocated amount is not the actual allocated amount of 50,000 yen in cost reduction. As manufacturing overhead costs are incurred from management resources indirectly involved in production, the management resources invested in production activities might not be effectively utilized (i.e., the human resources working in the indirect or auxiliary manufacturing departments, whose missions include receiving, inspection, warehousing, on-site transportation, maintenance, purchasing, production control, design, and cost accounting, as well as physical production resources such as machinery and equipment).

If these management resources are not effectively utilized, opportunity loss occurs in terms of lost opportunities to earn profits. Therefore, the unallocated amount of 50,000 yen in manufacturing overhead costs, which cannot be measured as a cost reduction, as well as the direct labor cost recognized as a fixed cost, reflect lost opportunities. In [Example 6], all manufacturing overhead costs are assumed to be fixed costs to simplify the discussion, but variable costs also generally exist in manufacturing overhead costs. In the case of variable costs, the Kaizen effect amount can be calculated as the cost reduction amount, as explained in the direct material cost. Thus, the recognition of the Kaizen effect on manufacturing overhead costs can be summarized as follows:

Kaizen effect amount of manufacturing overhead (variable cost)

= Cost reduction amount

Kaizen effect amount of manufacturing overhead (fixed cost)

= Opportunity loss amount

Kaizen effect amount of manufacturing overhead

= Cost reduction amount + Opportunity loss amount

Based on these calculations, it is possible to calculate the effect of Gemba Kaizen on direct material costs, direct labor costs, and manufacturing overhead costs, not only as a conventional cost reduction but also as an opportunity loss.

There has been significant interest in Gemba Kaizen being practiced in Japanese companies. However, little has been discussed about the accounting evaluation of Gemba Kaizen, or more specifically, the amount of Kaizen effect.

In Chapter 5, we discuss in detail the basic equation of GKC: Kaizen effect amount = Cost reduction amount + Opportunity loss amount.

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