ISSN 2189-9592

Journal of Japanese Management

Vol. 5, No.2, May 2021

JFMRA

Japan Federation of Management Related Academies

ISSN 2189-9592

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Journal of Japanese Management Vol.5, No.2, May 2021

The original English language edition published by JFMRA.

Journal of Japanese Management Vol.5, No.2, May 2021 ISSN 2189-9592

Contents

Alliance of medical malls: Conditions for the establishment of network practice

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Abstract

Network practice is a method of efficiently sharing patient information and making patient referrals, while utilizing information network technology among doctors. Although realizing alliances in a medical mall is difficult, it may be possible if network practice is carried out with the right partners. One of the reasons why alliances are difficult to establish in medical malls is that they may not meet the conditions that make the network practice possible in the first place. To investigate these conditions, we focused on the diagnostic sensitivity of doctors (hereafter, "sensitivity") and conducted a model analysis to determine the optimal partners to form an alliance. First, if the sensitivity of doctors is ensured at a high level, and there is a complementary relationship, network practice may be established. Second, network practice incurs transaction costs, which are influenced by sensitivity. Therefore, the higher the sensitivity, the lower the transaction cost and the higher the incentive for network practice. Third, the lower this sensitivity, the greater the mismatch between the patient and doctor's areas of diagnosis, and thus the greater the risk that patients will be interrupted in the course of their care. Therefore, to realize alliances in medical malls, it is necessary to devise ways to reduce transaction costs and match the diagnosis areas of patients and doctors, while making full use of information network technology and fulfilling the conditions for network practice.

Keywords

Medical malls, Alliance; Conditions for the establishment of the network practice; Diagnostic sensitivity; Transaction costs

(1) Introduction

1. Identification of the Problem

Although health care is known to be a regulated industry that requires publicity, safety, and reliability, thus making it difficult for competition to work, there is fierce competition among health care organizations. This is due to dramatic changes in the external environment,

including financial problems, health care reform, and soaring awareness of patients' rights (McSweeny-Feldand, Discenza, and Defeis, 2010; Bernardo, Valls, and Casadesus, 2012). In particular, Japan's long-term deflationary economy and rapidly aging population have led to an expansion of the health care cost-to-gross-domestic-product ratio, putting pressure on health insurance funding (Hashimoto et al., 2011). Therefore, to control the increasing rate of the country's overall health care costs and to make effective use of health care resources, the Japanese government is revising medical fees decreasingly, reducing the number of hospital beds, increasing patients' co-payments, and raising social insurance premiums and taxes on citizens. At the same time, hospitals and clinics are urged to rationalize and improve the efficiency of their management by promoting clear division of functions and mutual cooperation, as well as information technology, to provide low-cost, high-quality medical care (Ministry of Health, Labour and Welfare, 2015, 2016).

Owing to these circumstances, the number of hospitals peaked at 10,096 facilities in 1990 and has significantly decreased to 8,442 facilities in 2016, while the number of clinics has reached 101,529 facilities as of 2016, making the competitive environment surrounding clinics even more difficult (World Health Organization, 2018). However, it has been pointed out that clinics in Japan are usually run by a single specialist who has worked in a hospital, and thus have a small management scale and weak medical management and primary care[1]. As long as a single doctor runs a clinic, it is very difficult to ensure both the quality of medical care and the soundness of management. Therefore, medical malls have recently been adopted as a strategic alliance that transcends the boundaries of medical institutions. Their number has increased 6.7 times from about 375 in 2005 to 2,501 as of 2019 (Ito, 2020a).

To begin with, an alliance is defined as "*voluntary arrangements between firms involving exchange, sharing, or codevelopment of products, technologies, or services*" (Gulati, p. 293, 1998).

Although there is a long tradition and rich accumulation of management research on alliances, there are numerous definitions and no common concept due to the diverse perspectives and cross-cutting subject areas (Kinderis and Jucevičius, 2015). However, at the very least, there is no dispute that alliances represent a form of cooperation among multiple organizations to achieve a certain goal and that they are a strategic business form found in many markets regardless of industry. Its main effects are expected to be the following: an expansion of business scale, pursuit of profits, sharing of management resources, reduction of costs and risks, acquisition of learning effects including knowledge and know-how, and even reduction of excessive competition. However, there is no knowledge on medical malls (Kinderis and Jucevičius, 2015).

Medical malls, as a form of establishment in which multiple clinics and pharmacies are assembled in the same space, are mainly clustered in convenient locations for

[1] Primary care includes doctors, medical institutions, and medical services with which a patient comes into contact first. In Japan, it generally refers to outpatient care in clinics.

transportation and living, and they have the advantage of efficient access to appropriate specialists and departments, while selecting them according to the convenience of patients (Epstein, 2016; Ito, 2020b). Additionally, there are several advantages for even doctors. First, it allows for networked care. Network practice is a new method of efficient patient information sharing and referral coordination among doctors using information network technology. In medical malls, doctors are spatially close, so the introduction of networked care can be advantageous. It has long been common in primary care in Western countries for multiple doctors to collaborate to provide group practice, but the difference is that this is not necessarily based on the use of information network technology (Josi and Pietro, 2019). However, since networking is an essential element in realizing alliances, this paper discusses the premise of adopting a networked practice (Bernardo et al., 2012).

Another advantage is that high-cost medical equipment such as computed tomography and magnetic resonant imaging can be shared in a medical mall to guarantee utilization rate and reduce the risk of overinvestment. Furthermore, the sharing of consultation tickets issued to patients can reduce the waste of consultation procedures. As a result, doctors can be freed from these administrative tasks and concentrate on medical care.

As previously described, medical malls that have introduced networked medical care have an incentive to form alliances among doctors because they can strengthen management functions through efficient sharing of management resources and provision of high-quality medical care among clinics.

However, it should also be noted that alliances are not a universal management strategy or solution (Vattikoti and Razak, 2018). For example, it has been reported that half of the alliances fail and conversely, performance declines (Varadarajan and Cunningham, 1995). Nevertheless, few solutions to problems related to alliances have been identified (Albers, Wohlgezogen, and Zajac, 2013). In particular, medical malls have long been pointed out as a future management issue because of the difficulty of cooperation among clinics (Ito, 2016). So, how can alliances be realized in medical malls? This is the research question of this paper.

Then, can the network model of online shopping malls not be used as a reference? We may be able to refer to online shopping malls, which have already built models of matching stores and consumers and providing convenient services. In addition, several studies of online shopping malls have reported the results of research that modeled the relationship between stores and consumers (Ahna, Ryu, and Han, 2004; Macmillan, 2009). Indeed, the two are similar in that they both provide convenient and complex services through the concentration of multiple stores. Moreover, online shopping is highly appreciated because consumers value the quality of service that enables contactless shopping experience. This implication is also applicable to network practices. However, this approach should be applied with caution because the assumptions of transactions are fundamentally different in the medical and general commercial sectors. For example, price competition is not allowed in the medical field, and advertising is strictly regulated; therefore, one cannot advertise freely. Moreover, one cannot open a business without a doctor's

license, and the barriers to entry are high. Furthermore, word of mouth and rankings do not always reflect the quality of medical care. Therefore, it is necessary to propose an original model that takes these circumstances into account.

2. Study Objectives and Methods

This study examines the management issues for the realization of alliances in medical malls. It has been pointed out that the background to the difficulty of alliances in medical malls is related to the large transaction costs between clinics (Ito, 2016). The following two issues are considered to be the main causes of this increased transaction cost.

The first is that the majority of clinics still rely on paper medical records and fax machines, and have not yet adopted information network technology, resulting in very inefficient collaboration among clinics. However, this problem should be solved by introducing the information technology mentioned earlier (Hajli et al., 2014). Second, the choice of partners is very important for the success of an alliance, but there has not been sufficient discussion on what kind of relationship is appropriate to establish (Hitt et al., 2000). In particular, to realize alliances in medical malls, incentives to establish network practice are necessary, but it is suspected that these may not be functioning effectively in practice. Medical care is inherently very different from other service industries in that it affects the prognosis of the patient's life, and it is a profession that requires safety and reliability with the highest priority. Therefore, doctors are strongly required to possess autonomy and ethics as professionals. For this reason, network practice, which pursues only commercial purposes and leads to a decline in quality, is not allowed. In other words, the quality of the partner doctor is considered to be a major incentive for the establishment of a network practice. Therefore, an alliance of medical malls may be feasible if the network practice can be carried out with appropriate partners. However, there are few studies on this topic because it is a sensitive issue that deals with the qualifications of doctors and has been avoided until now.

The purpose of this study was thus to clarify the conditions for the establishment of networked medical care in medical malls, focusing on diagnostic sensitivity (hereafter, "sensitivity") as a quality of doctors.

First, in Section 2, we propose a method to evaluate the quality of doctors using sensitivity, and we conduct a model analysis of the difference in sensitivity between solo and network practice. In addition, we will classify alliances among doctors into three cases and elucidate the cases in which network practice can be established. Furthermore, we will analyze the problem of transaction costs, which is considered to be the main disincentive for network practice, in relation to the sensitivity of doctors. In Section 3, we discuss the conditions for the establishment of network medical care based on the results of these studies, as well as the limitations and future challenges of this research. Finally, in Section 4, we conclude with recommendations on the conditions for the establishment of networked medical care and issues for the realization of alliances.

(2) Model Analysis of a Network Practice

1. Solo Practice Model

The sensitivity discussed here refers to the probability that a doctor can correctly diagnose a patient's disease. Although it is difficult to

measure the sensitivity of individual doctors strictly, it is possible to measure it experimentally by identifying diseases and using image findings. For example, a reading test can be conducted by mixing symptomatic and Diagnostic images to determine the sensitivity in this area (Ito, 2017). Alternatively, a method to determine sensitivity from the false positive rate can be considered.

In this paper, the following symbols will be introduced to discuss the sensitivity of doctors:

- i: Doctor's number $(i = 1, \cdots, m)$
- j: Number of the diagnosis area $(j = 1, \cdots, n)$

(In general, m and n can be different.)

-Sensitivity of doctor i: P_i $(i = 1, \cdots, m)$

-Sensitivity of diagnosis area j of doctor i: P_{ij}

$$(i = 1, \cdots, m, \quad j = 1, \cdots, n)$$

-Total number of patients: N

-Number of patients who visit doctor i: N_i

$$\left(\sum_{i=1}^{m} N_i = N\right)$$

-Number of patients in diagnosis area j who see doctor i: N_{ij}

$$\left(\sum_{j=1}^{n} N_{ij} = N_i, \quad i = 1, \cdots, m\right)$$

-Number of patients in diagnostic area j : N^j

$$\left(\sum_{i=1}^{m} N_{ij} = N^j, \quad j = 1, \cdots, n, \quad \sum_{j=1}^{n} N^j = N\right)$$

In this section, we assume that Ni = 1 or higher. This is because a doctor with Ni = 0 (For example, such case happens when the number of doctors is larger than patients, or when a particular doctor has a monopoly on patients) is assumed to have low sensitivity, and network practice with such a doctor is unrealistic to improve sensitivity. The sensitivity of doctor i, P_i , and the mean sensitivity of all doctors, P_{mean} of all the doctors are determined as follows:

$$P_i = \frac{\sum_{j=1}^{n} P_{ij} N_{ij}}{N_i} = \frac{P_{i1}N_{i1} + P_{i2}N_{i2} + \cdots + P_{in}N_{in}}{N_{i1} + N_{i2} + \cdots + N_{in}}$$

$$P_{mean} = \frac{\sum_{i=1}^{m} P_i}{m} = \frac{P_1 + P_2 + \cdots + P_n}{m}$$

When $m = n$, the network practice sensitivity P_g for the entire doctor population is defined as follows:

$$P_g = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} = \frac{P_{11}N^1 + P_{22}N^2 + \cdots + P_{nn}N^n}{N^1 + N^2 + \cdots + N^n}$$

As suggested by these equations, the sensitivity used in this study depends on the number of patients per diagnosis area. Hereafter, $m = n$.

As previously described, by controlling the numerical values of P_{ij} and N_{ij}, we can consider various degrees of matching between the diagnosis area by the doctor and the diagnosis area required by the patient.

2. A Network Practice Model from the Perspective of Three Alliances

2.1 Cases of Complementary Relationships between Doctors

First, we consider the case where each doctor is a specialist and excels in diagnosing one of the medical areas.

In particular, doctor i is a case with great sensitivity in clinical area i:

$$P_{ii} \geq P_{ij} \ (j \neq i)$$

Consider the case where the above equation holds.

This means that doctors complement each other, and do not compete in their area of practice.

Case 1: The sensitivity of each doctor's specialty is equal

The first simple case

$$P_{11} = P_{22} = \cdots = P_{nn}$$

is equal. In this case,

$$P_g = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} = P_{11} \frac{\sum_{i=1}^{n} N^i}{N} = P_{11}$$

This means that the network practice sensitivity is equal to the sensitivity of each doctor's specialty area. In addition,

$$P_i = \frac{\sum_{j=1}^{n} P_{ij} N_{ij}}{N_i} \leq \frac{P_{ii} \sum_{j=1}^{n} N_{ij}}{N_i} = P_{ii} = P_g$$

From the above equation, we can see that the network practice sensitivity is larger for any doctor. Also, in this case, $P_{mean} \leq P_g$.

From this, we can say that there is an incentive to adopt network practice when the doctors are complementary, and each doctor has equal sensitivity in his or her area of expertise. The numerical example in this case corresponds to Case (a) in Tables 1 and 2.

Case 2: There is variation in sensitivity.

The difference between the network practice sensitivity and the average sensitivity of all doctors can be calculated as follows.
First, from $P_i \leq P_{ii}$,

$$P_g - P_{mean} = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} - \frac{\sum_{i=1}^{n} P_i}{n}$$
$$\geq \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} - \frac{\sum_{i=1}^{n} P_{ii}}{n}$$

The above equation can be derived, but in order for it to be positive

$$\sum_{i=1}^{n} P_{ii} N^i \geq \frac{\sum_{i=1}^{n} P_{ii}}{n} N$$

That is, $N = \sum_{i=1}^{n} N^i$, and dividing by n on both sides, the following equation is obtained:

$$\frac{1}{n} \sum_{i=1}^{n} P_{ii} N^i \geq \left(\frac{1}{n} \sum_{i=1}^{n} P_{ii} \right) \left(\frac{1}{n} \sum_{i=1}^{n} N^i \right)$$

This is known as Chebyshev's sum inequality:

$$P_{11} \geq P_{22} \geq \cdots \geq P_{nn},$$
$$N^1 \geq N^2 \geq \cdots \geq N^n$$

When such a relationship exists, the inequality holds. In other words, this is a situation where the order of magnitude of the sensitivity of the doctor's areas of expertise exactly matches the order of the number of patients in each of those areas.

This shows that doctors are complementary to each other and have an incentive to adopt network practice whenever there is a patient in each domain corresponding to the magnitude of the doctor's sensitivity. The numerical example for this case is Case (b) in Table 1. However, since this is a sufficient condition, there may be situations where the network clinic sensitivity is greater even when there is no such correspondence. For example, consider Case (b) in Table 2.

In general, it can also be calculated as follows:

$$P_g - P_{mean} = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} - \frac{\sum_{i=1}^{n} P_i}{n}$$

$$= \frac{1}{n} \left(\frac{n \sum_{i=1}^{n} P_{ii} N^i}{N} - \sum_{i=1}^{n} \frac{\sum_{j=1}^{n} P_{ij} N_{ij}}{N_i} \right)$$

$$= \frac{1}{n} \sum_{i=1}^{n} \left(\frac{\sum_{j=1}^{n} P_{jj} N^j}{N} - \frac{\sum_{j=1}^{n} P_{ij} N_{ij}}{N_i} \right)$$

$$= \frac{1}{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \left(\frac{P_{jj} N^j}{N} - \frac{P_{ij} N_{ij}}{N_i} \right)$$

Therefore, for each i, j

$$\frac{P_{jj} N^j}{N} - \frac{P_{ij} N_{ij}}{N_i} \geq 0$$

we can say that there is an incentive to adopt a network practice. Even if this becomes a negative number for some i, j, the sum for all i, j should be positive. Further in text, we consider a situation where this inequality holds.
First, for $i = j$, the inequality is as follows.

$$\frac{N^i}{N} \geq \frac{N_{ii}}{N_i}$$

Table 1 Comparison of mean sensitivity P_{mean} and network practice sensitivity P_g for Doctor 1 and Doctor 2

Case	(P11, P12)	(P21, P22)	(N11, N12)	(N21, N22)	N^1	N^2	P1	P2	Pmean	Pg
(a)	(0.9, 0.6)	(0.5, 0.9)	(500, 500)	(500, 500)	1000	1000	0.75	0.70	0.73	0.90
(b)	(0.9, 0.4)	(0.5, 0.7)	(800, 200)	(400, 600)	1200	800	0.80	0.62	0.71	0.82
(c)	(0.9, 0.4)	(0.5, 0.7)	(200, 600)	(1000, 200)	1200	800	0.53	0.53	0.53	0.82
(d)	(0.9, 0.3)	(0.2, 0.5)	(300, 100)	(100, 1500)	400	1600	0.75	0.48	0.62	0.58
(e)	(0.9, 0.7)	(0.9, 0.6)	(600, 400)	(600, 400)	1200	800	0.82	0.78	0.80	0.78
(f)	(0.9, 0.7)	(0.9, 0.6)	(900, 500)	(100, 500)	1000	1000	0.83	0.65	0.74	0.75
(g)	(0.9, 0.7)	(0.3, 0.4)	(800, 800)	(200, 200)	1000	1000	0.80	0.35	0.58	0.65
(h)	(0.9, 0.7)	(0.3, 0.4)	(200, 100)	(200, 1500)	400	1600	0.83	0.39	0.61	0.50

Source: Created by the author.

Then, the left-hand side is the percentage of patients seen by doctor i after the network practice, and the right-hand side is the percentage of patients in practice area i seen by doctor i before the network practice. In other words, the proportion of patients seen by doctor i who specializes in area i must increase with the implementation of network practice. This is a requirement that must be met when introducing network medical care.

Then for $i \neq j$, the inequality is

$$\frac{N^j}{N} \geq \frac{P_{ij}}{P_{jj}} \cdot \frac{N_{ij}}{N_i} \qquad \cdots *)$$

and this equation is rewritten as *),

where the left-hand side represents the percentage of patients that doctor j sees after the network treatment, the first part of the right-hand side represents the ratio of the sensitivity of doctor i and doctor j to diagnosis area j, and the back part represents the percentage of patients in clinical area j for doctor i before the network treatment. Since $P_{ij}/P_{jj} \leq 1$ if $P_{jj} \geq P_{ij}$, we know that network practice should result in the proportion of patients seen by a specialist being greater than the proportion of patients seen by a non-specialist multiplied by the sensitivity ratio. This is a situation that should be met in many cases when network practice is used, but in some very special cases, $P_{mean} \geq P_g$ (see Case (d) in Tables 1 and 2).

2.2 Cases of Competing Doctors

Second, we will consider the case where the sensitivities of the doctors are in a competitive relationship. In other words, the sensitivity of a certain Doctor 1 and Doctor 2 is $P_{11} \leq P_{21}$. In this case, $P_{21}/P_{11} \geq 1$, and N_{21}/N_2 must be small enough to satisfy the inequality*). This means that the percentage of patients in Diagnosis Area 1 that Doctor 2 sees is small. This case is unlikely to occur because Doctor 2 specializes in Diagnosis Area 1. In other words, there is no incentive to provide network care in cases where there is a competitive relationship (see Tables 1 and 2 Cases (e) and (f)). However, since the sensitivity of the two doctors is the same, and the quality of their medical care is guaranteed, there may be an incentive to form an alliance if the clinic is closed for some reason or if the number of patients increases and other doctors are needed to support the clinic. In other words, this can be interpreted as a conditional establishment of a network practice when

Table 2 Comparison of mean sensitivity P_{mean} and network practice sensitivity P_g for Doctor 1, Doctor 2, and Doctor 3

Case	(P_{11}, P_{12}, P_{13}) (N_{11}, N_{12}, N_{13})	(P_{21}, P_{22}, P_{23}) (N_{21}, N_{22}, N_{23})	(P_{31}, P_{32}, P_{33}) (N_{31}, N_{32}, N_{33})	N^1	N^2	N^3	P1	P2	P3	Pmean	Pg
(a)	(0.9, 0.6, 0.3) (500, 500, 500)	(0.5, 0.9, 0.4) (500, 500, 500)	(0.3, 0.5, 0.9) (500, 500, 500)	1500	1500	1500	0.60	0.60	0.57	0.59	0.90
(b)	(0.9, 0.6, 0.3) (800, 300, 200)	(0.5, 0.8, 0.4) (500, 700, 400)	(0.3, 0.5, 0.7) (300, 400, 900)	1600	1400	1500	0.74	0.61	0.58	0.64	0.80
(c)	(0.9, 0.6, 0.3) (300, 400, 800)	(0.5, 0.8, 0.4) (600, 300, 600)	(0.3, 0.5, 0.7) (800, 400, 300)	1700	1100	1700	0.50	0.52	0.43	0.48	0.80
(d)	(0.9, 0.7, 0.6) (100, 400, 1000)	(0.6, 0.7, 0.6) (100, 400, 1000)	(0.4, 0.4, 0.5) (100, 300, 1200)	300	1100	3200	0.65	0.63	0.48	0.58	0.57
(e)	(0.9, 0.6, 0.3) (800, 500, 300)	(0.8, 0.5, 0.4) (800, 500, 300)	(0.7, 0.5, 0.2) (800, 300, 200)	2400	1300	800	0.69	0.63	0.58	0.63	0.66
(f)	(0.9, 0.6, 0.3) (800, 500, 300)	(0.8, 0.5, 0.4) (500, 800, 300)	(0.3, 0.5, 0.9) (200, 300, 800)	1500	1600	1400	0.69	0.58	0.72	0.66	0.76
(g)	(0.9, 0.8, 0.7) (1000, 900, 800)	(0.4, 0.5, 0.3) (400, 500, 300)	(0.1, 0.2, 0.3) (100, 200, 300)	1500	1600	1400	0.81	0.42	0.23	0.49	0.57
(h)	(0.9, 0.8, 0.7) (300, 200, 100)	(0.4, 0.5, 0.3) (200, 500, 400)	(0.1, 0.2, 0.3) (200, 800, 1800)	700	1500	2300	0.83	0.41	0.26	0.50	0.46

Source: Created by the author.

doctors are competing with each other in their areas of practice.

2.3 Case of a Superior–Inferior Relationship between Doctors

Third, consider a case in which one doctor has high sensitivity and the other doctor has extremely low sensitivity, i.e., a "superior–inferior" relationship. In other words, if the sensitivity of Doctor 1 and Doctor 2 is assumed to be satisfied.

$$\min_k P_{1k} \geq \max_k P_{2k}$$

This is the case where the sensitivity of all regions of Doctor 2 is lower than the least sensitive region of Doctor 1. In this case, as in the case of (1), $P_g \geq P_{mean}$, and there is an incentive to adopt network practice. However, considering the very rare case, $P_{mean} \geq P_g$ may also be true (see Table 1 case(e)(h)). In addition,

$$\min_i P_{ii} = P_{22}, \ \max_i P_{2i} = P_{22},$$

and so on. In other words, Doctor 2 has Area 2 as the highest sensitivity, but it is lower than the sensitivity of any other doctor's specialty.

In this case,

$$P_g = \frac{\sum_{i=1}^{n} P_{ii} N^i}{N} \geq \frac{\sum_{i=1}^{n} P_{22} N^i}{N} = P_{22}$$

$$P_2 = \frac{\sum_{j=1}^{n} P_{2j} N_{2j}}{N_2} \leq \frac{\sum_{j=1}^{n} P_{22} N_{2j}}{N_2} = P_{22}$$

and $P_g \geq P_2$ always holds.

This implies that there is an incentive for Doctor 2 to have a network practice. This has implications for the possibility of supporting low-sensitivity doctors as a whole (see Tables 1 and 2 Case (g), (h)). This finding is also consistent with the view that there is an endorsement effect when low quality organizations join alliances (Stuart, 2000).

2.4 Sensitivity Analysis

In this section, we attempted a sensitivity analysis for the three cases mentioned above, with several numerical examples thrown in. Table 1 shows the results for $n = 2$, and Table 2 shows the results for $n = 3$. However, we fixed $N = 2{,}000$ for $n = 2$ and $N = 4{,}500$ for $n = 3$. In both cases, Cases (a), (b), (c), and (d) show complementary relationships, Cases (e) and (f) show competitive relationships, and Cases (g) and (h) show dominance–subordination relationships.

In Case (a), the sensitivity of the specialty was equal, as well as the number of patients; in Case (b), there was a small difference in the sensitivity of the specialty, but the number of patients was correspondingly large; and in Case (c), the sensitivity of network practice was high when many patients visited doctors from different diagnosis areas. Conversely, in Case (d), the network practice sensitivity was small when there were few patients who should visit a doctor with high sensitivity and many patients who should be seen by a doctor with low sensitivity. In addition, (e), which is competitive, was reversed. The same was true for (f), which was competitive but had a higher network practice sensitivity. Even in the dominant–subordinate relationship, there were cases where (g) network sensitivity was high, and cases where (h) network sensitivity was low.

3. A Network Practice Model That Reflects Transaction Costs

When providing networked medical services, a variety of labor and coordination burdens are incurred. For example, there are many transaction costs, such as obtaining patient consent, preparing referral letters, sending and receiving clinical information, transcribing medical records and test data, and coordinating retest requests and hospital admissions and discharges. The magnitude of these costs is thought to depend on the quality of the doctor. For example, if a doctor is highly sensitive, he or she will be able to provide appropriate medical care efficiently and collaborate seamlessly with other doctors. Conversely, if the doctor's sensitivity is low, the medical treatment will be inappropriate, and when collaborating, many tasks will need to be reconfirmed, and questionable referrals will occur, which is inefficient and may increase transaction costs. For this reason, the introduction of diagnostic support systems and electronic health records (EHR) has recently been recommended to reduce such transaction costs, but it has not necessarily spread to the national level (Tanaka, 2007). However, as long as the existence of transaction costs is left unaddressed, it is difficult to develop networked medical care, so it is necessary to understand transaction costs to improve the problem.

Here, we define it as follows:

- $1 - P_{ij}$: cost incurred by doctor i to see one patient in area j
- k : a uniform burden rate for providing network medical services.

In other words, the higher the sensitivity, the lower the cost. In this case, the total cost before network clinic is the following equation:

$$C_{before} = \sum_{i=1}^{n}\sum_{j=1}^{n}(1 - P_{ij})N_{ij}$$

The total cost of a network practice can be calculated as follows:

$$C_{after} = \sum_{i=1}^{n}(1 - P_{ii})N^{i}$$

Furthermore, if $k \cdot C_{after} \leq C_{before}$, the total

Table 3 Total cost comparison before and after the network practice (corresponding to the cases in Tables 1 and 2 (left) n=2, (right) n=3)

Case	Before	After	*1/k*
(a)	550	200	0.36
(b)	580	360	0.62
(c)	940	360	0.38
(d)	930	840	0.90
(e)	400	440	1.10
(f)	450	500	1.11
(g)	580	700	1.21
(h)	1090	1000	0.92

Case	Before	After	*1/k*
(a)	1850	450	0.24
(b)	1650	890	0.54
(c)	2320	900	0.39
(d)	1930	1960	1.02
(e)	1630	1530	0.94
(f)	1540	1090	0.71
(g)	1680	1930	1.15
(h)	2830	2430	0.86

Source: Created by the author.

Table 4 Comparison of interruptions in outpatient care (corresponding to the cases in Tables 1 and 2 (left) n=2, (right) n=3)

Case	L_1	L_2	Lg
(a)	0.25	0.30	0.10
(b)	0.20	0.38	0.18
(c)	0.48	0.47	0.18
(d)	0.25	0.52	0.42
(e)	0.18	0.22	0.22
(f)	0.17	0.35	0.25
(g)	0.20	0.65	0.35
(h)	0.17	0.61	0.50

Case	L_1	L_2	L_3	Lg
(a)	0.40	0.40	0.43	0.10
(b)	0.26	0.39	0.43	0.20
(c)	0.50	0.48	0.57	0.20
(d)	0.35	0.37	0.53	0.43
(e)	0.31	0.37	0.42	0.34
(f)	0.31	0.43	0.28	0.24
(g)	0.19	0.58	0.77	0.43
(h)	0.17	0.59	0.74	0.54

Source: Created by the author.

cost of adopting network practice will be small and there is an incentive. Moreover, if

$$1/k = C_{before}/C_{after}$$

we can estimate how much we can bear when adopting network practice. Table 3 summarizes the values of C_{before}, C_{after}, and $1/k$ for the cases in Tables 1 and 2. For example, Case (a) with the smallest $1/k$ in the left table ($1/k$ =0.36) means that there is an incentive even if the transaction cost corresponding to 100% - 36% = 64% is incurred as a result of network treatment. On the other hand, (g), has the highest $1/k$, that is, 1.21. However, there is no incentive because the network practice generates transaction costs equivalent to 121%, which, conversely, is an increased burden compared to the solo practice. Hence, (a) can be interpreted as more desirable than (g).

4. The Problem of Interruption of a Visit to an Outpatient Clinic

4.1 Outpatient Clinic Interruption Model

Furthermore, to increase the effectiveness of network practice, it is important to match the areas of practice of patients and doctors as much as possible. In a study by National Federation of Health Insurance Societies (2000), it was reported that 32.2% of patients visited more than one medical institution at the same time for the same injury or illness, so this may be happening because of a mismatch between patients' and doctors' practice areas (National Federation of Health Insurance Societies, 2017). Therefore, the risk of these mismatched patients interrupting the course of their care is Interruption level: L_i

$$L_i = 1 - P_i, (0 \leq L \leq 1)$$

As shown above, it can be calculated by simply subtracting the sensitivity of the target doctor from the maximum sensitivity value. Thus, we can use the following numerical examples for each parameter

$$P_{11} = 0.8,\ P_{12} = 0.6,\ P_{21} = 0.6,\ P_{22} = 0.8$$

$$N_{11} = N_{12} = N_{21} = N_{22} = 500$$

then the degree of interruption of outpatient care for each doctor in the case of solo care is

$$L_1 = 1 - P_1 = 1 - 0.7 = 0.3$$

$$L_2 = 1 - P_2 = 1 - 0.7 = 0.3$$

Therefore, we can say that both Doctor 1 and Doctor 2 cause a mismatch of 30% of all patients diagnosed. On the other hand, L_g during network practice is

$$L_g = 1 - P_g = 1 - 0.8 = 0.2$$

and mismatch occurs in 20% of patients, indicating that the possibility of interruption of hospital visits is reduced by one-third compared to solo care.

Table 4 summarizes the values of L_i and L_g for each of the cases in Tables 1 and 2.

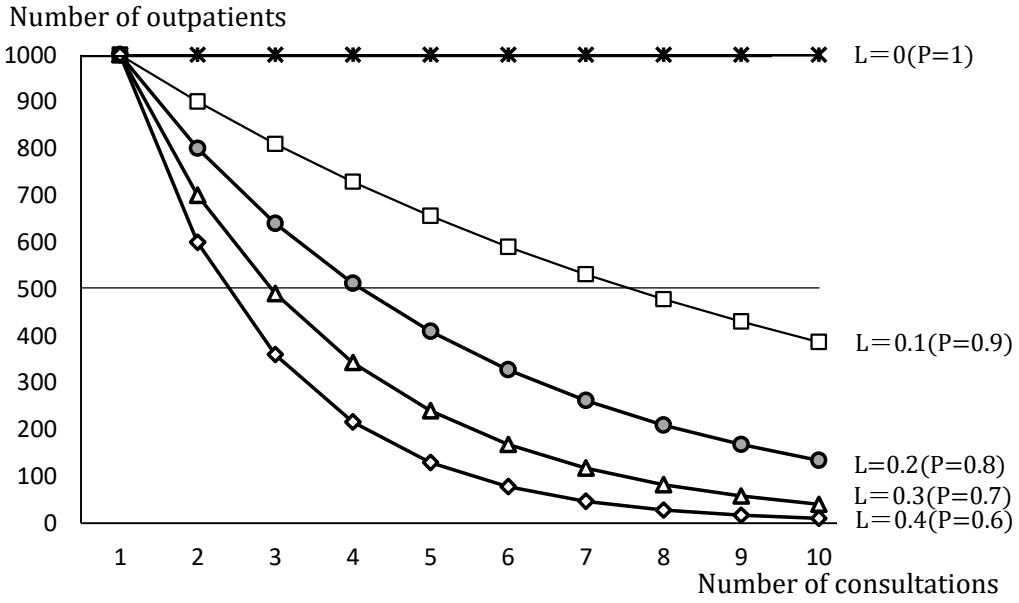
4.2 Simulation of the number of patients by the number of visits using the interruption level of outpatient care

Next, we attempted to simulate the number of patients by the number of visits using the "Outpatient Care Disruption Model" to clarify the relationship between doctor sensitivity and patient interruptions. In this study, we tentatively set the upper and lower limits of the doctor's sensitivity level to five levels in increments of 0.1, from the maximum value of 1 to 0.6. We assumed that the average number of outpatients per month in a typical clinic is 1,000, and that the number of patients who require regular visits and are mismatched to the doctor's area of practice is interrupted (reduced) with each visit. For convenience of analysis, we did not include the number of new patients. With the above parameters, we estimated how much the number of patients would decrease each time a patient visited the doctor in question. The results are shown in Figure 1.

As a result, at $P = 1$, the number of patients was steady regardless of the number of visits, because the patients and doctors were perfectly matched in their fields of practice. However, at $P = 0.9$, the number of patients was halved at the seventh visit, at $P = 0.8$ at the fourth visit, and at $P = 0.7$ and 0.6 at the third visit. Therefore, it can be interpreted that the larger these mismatches are, the greater the risk that patients will interrupt their visits.

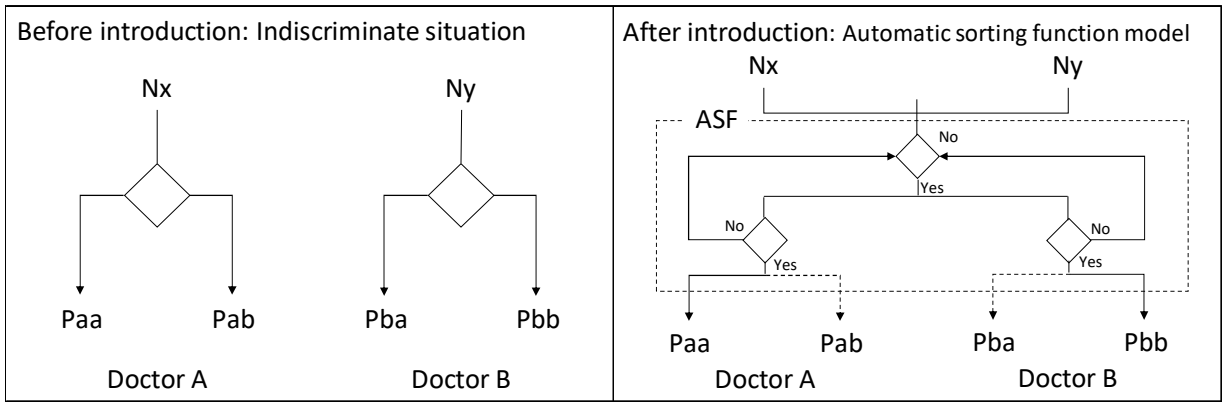
5 Possibility of matching clinical areas in patients and doctors by introducing automatic sorting function

Finally, what about the case where patients



Source: Created by the author.

Figure 1 Estimated number of outpatients by expected loss



Note：$N_x = N_y = (N_a + N_b)$, $N_a : N_b = 1 : 1$

Source: Created by the author.

Figure 2 Automatic sorting function model

can select appropriate specialists and departments before visiting a medical institution? It is empirically known that, in general, the purpose and function of specialty hospitals are more clearly defined than those of general hospitals, which makes it easier for patients to identify specialists and departments and to match patients and doctors in their fields of practice. This situation is naturally expected to be a signaling to patients in medical malls that are composed mainly of specialists. In particular, to increase the effectiveness of networked medical care, if artificial intelligence (AI)-equipped questionnaires are introduced at the general counter of medical malls and reflected in patients' medical choices, efficient matching by patients and doctors can be achieved (Petkus and Hoogewerf et al., 2020). Let us look at Figure 3 now. The left-hand side shows a situation where the automatic selection function has not yet been introduced, that is., in an indiscriminate manner, Doctor A is treating patient group N_x and Doctor B is treating patient group N_y solo. Here

Patient group in Clinical Area A: N_a

Patient group in Clinical Area B: N_b

$$N_x = N_y = N_a + N_b$$

$$N_a : N_b = 1 : 1$$

and assume that the patients are evenly distributed in the Treatment Areas A and B.

On the other hand, the sensitivities of Doctors A and B are

-Sensitivity of Doctor A's area of Practice A: P_{aa}

-Sensitivity of Doctor A's area of Practice B: P_{ab}

-Sensitivity of Doctor B's area of Practice A: P_{ba}

-Sensitivity of Doctor B's area of Practice B: P_{bb}

Let us assume that here, we have

- $P_{aa} \geq P_{ab}$
- $P_{bb} \geq P_{ba}$
- $P_{aa} \geq P_{ba}$
- $P_{bb} \geq P_{ab}$

then Doctor A is dominant in Practice Area A, and Doctor B is dominant in Practice Area B, meaning that they are complementary.

At this time, it is optimal for N_a to see Doctor A and N_b to see Doctor B. However, as long as N_a and N_b see doctors indiscriminately without taking into account the expertise of the two doctors, that is, the superiority of their areas of practice, half of the patients will theoretically experience a mismatch.

However, the right side of Fig. 2 shows a situation in which a medical questionnaire with AI can be used to automatically select a Doctor

A or Doctor B that matches the medical fields of N_a and N_b. For example, by having N_a and N_b answer this questionnaire in advance at the general counter, one of the two doctors with high sensitivity can be appropriately selected. This will reduce the mismatch between the patient and the doctor in the area of medical care to the maximum value of the doctor's sensitivity, and also reduce the risk of patient interruption.

(3) Discussion

In this study, we examined the conditions for the establishment of a network practice, focusing on the sensitivity of doctors to realize an alliance in a medical mall. As a result, it was found that in addition to "ensuring a high level of sensitivity of the partner doctors," "complementary relationships" would have the effect of increasing the sensitivity of the entire practice. Therefore, if the above two conditions are met, networked medical care can be established, and benefits that cannot be demonstrated by individual doctors can be provided to both doctors and patients. In other words, this conclusion means that a medical mall alliance will not be realized by blindly gathering doctors without taking these two conditions into consideration.

Furthermore, to increase the feasibility of alliances, we must make full use of information network technology. This is because the effective use of such technology will make it easier to reduce transaction costs between doctors and eliminate mismatches between patients and doctors without placing an undue burden on the medical field. However, in recent policy debates, the argument for limiting free access has been accelerated because many people perceive that allowing free access has led to patients' preference for large hospitals and the problem of excessive medical care known as doctor shopping. However, the premise of this debate is undesirable because it may divide the relationship between patients and medical professionals. Certainly, the problem of overmedication should not be left unaddressed, but it is an oversimplification to interpret this as unreasonable demands or lack of health literacy on the part of patients.

In this paper, to explore the relationship between the mismatch of medical fields and patients' interruption of outpatient care, we tried a simulation and found that the higher the sensitivity of the doctor, the lower the risk of interruption (Figure 2). In light of this fact, it may rather be due to the mismatch between patients and doctors in their areas of practice. To prevent fragmentation and unnecessary confusion between patients and medical professionals, and to maintain a good relationship between both parties, we should seek to solve the problem through technical assistance, while allowing free access whenever possible. Nevertheless, these efforts are fragile in the medical field. This paper is novel because it proposes the conditions for the establishment of network practice as one of the solutions to these problems.

In this study, we proposed the automatic sorting function model as a mechanism to match patients and doctors at the initial stage of their visit to a medical mall. When a patient visits the general information desk of a medical mall for the first time, a medical questionnaire with AI can be used to efficiently select an appropriate specialist and department (Figure 3). This is a problem that can be realized using modern ICT, and it is not a difficult method. However, conventional discussions have lacked the perspective of problem solving using the

latest technology. Therefore, a model that would match doctors and patients by applying information network technology is novel in this study. The question is, however, why is it that these models are not widely used in the medical field? The issue of concern here is that the initial cost of EHRs is unusually high, regardless of the country, and this is hindering the spread of the technology (The Commonwealth Fund, 2020; Nakamura, 2006). The Japanese government has been injecting huge subsidies to medical institutions to compensate for the high initial costs in an effort to improve this situation, but the introduction of this technology on the premise of subsidies in the absence of appropriate prices in the field has caused problems that have in turn induced cost increases. Hence, if these technologies do not spread due to the adverse effects of such price hikes, it may be difficult to realize alliances and increase the effectiveness of networked medical care, and further discussion is needed in the future. However, since the aforementioned conditions of establishment have been met in medical malls, which have in fact established the network practice with their own financial resources, it is believed that there is potential for application (Ito, 2017).

Finally, there are several limitations to this study. First, since the sensitivity analysis of doctors employed in this study is only a model analysis with certain constraints, a methodological study on specific measurement and evaluation is needed. In conjunction with this, verification of the relationship between doctor sensitivity and interruptions in patient outpatient care is required. Additionally, the issue of transaction costs occurring in medical malls needs to be investigated and verified in more detail. For example, computer simulations are required to verify the effectiveness of this model when applied to medical malls. Furthermore, this analysis did not take into account the relationship between network practice and doctor capacity. In this study, the discussion was based on the assumption that Ni = 1 or higher, but when considering the doctor capacity issue, it may be possible even for doctors with low sensitivity to participate in network practice. Therefore, it is expected that these research issues will be further discussed in the future. However, I would like to emphasize that the contribution of this study is that it focused on the issue of alliances, which has been a concern in medical malls for some time and led to a method to increase the feasibility of alliances by satisfying the conditions for the establishment of a network practice. This method has value that can be applied to the management of medical malls.

(4) Conclusion

To realize an alliance in a medical mall, the choice of partners is extremely important, and a network practice must be established under the appropriate partners. Therefore, the following two conditions must be met to establish a network practice:

1. The sensitivity of the doctors must be at a high level.
2. Doctors must have a complementary relationship with each other.

The importance of alliances has long been touted among medical professionals, but to make them a reality, it is essential that the doctors themselves are qualified and have a specialty in which they excel, in other words, that they have an advantage over other doctors. In addition, since alliances always involve transaction costs, these costs should be covered

by actively utilizing information network technology. Furthermore, by making full use of information network technology, transaction costs can be reduced, and matching of patients and doctors in their areas of practice can be achieved. Therefore, to realize alliances in medical malls, further efforts are expected to be made to lower prices to the electronic medical record industry side, while promoting active investment in information technology by the clinics' own funds, rather than assuming subsidies.

Acknowledgements

This work was supported by the Japan Society for the Promotion of Science KAKENHI grant number 18K12831.

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(Received: January 15, 2021)
(Accepted: March 10, 2021)

Adjustment of allocation plans for stock-based compensation costs*

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Abstract

Prior research has considered accounting for stock options based on the idea that stock options require recognition of the costs associated with the consumption of labor services. This study uses normative and descriptive research to consider the logical necessity of accounting in the revision phase of plans for the allocation of stock-based compensation costs. Because revision of numbers to actual amounts is also performed in other fields of accounting, the number of stock options granted will be adjusted even when there are no specific modifications. We also discuss the modification of allocation plans (without specifying whether the corresponding account of the cost is a liability or equity), using allocation procedures in other fields of accounting. We found that in revising allocation plans for stock-based compensation, a revision procedure (accounting for adjusting the numbers of stock options granted) similar to that of the current standards can be considered as the widely accepted theory. Remeasuring at fair value of stock options at each reporting date is not a nontrivial solution for revision procedure (accounting for modification). Also, the procedure for modifying the allocation plan for stock-based compensation (accounting for adjusting the number and modification), regardless of whether the corresponding account of costs is a liability or equity, can be a powerful theory.

Keywords: stock options; allocation plans; stock-based compensation costs; the numbers of stock options granted; modification

(1) Introduction

This study uses normative and descriptive research to consider the logical necessity of accounting in the revision of plans for the allocation of stock-based compensation costs (accounting for adjusting the number of stock options and modification). All major global accounting standards, including the Japanese

* This paper is part of the research results supported by the JSPS Grant-in-Aid for Scientific Research (Early Career Scientists: Research Project No. 20K13640) and the 2020 Takasaki City University of Economics Special Research Grant. I would like to thank Editage (www.editage.com) for English language editing.

generally accepted accounting practices (JGAAP) set by the Accounting Standards Board of Japan (ASBJ), call for the provision of useful information for decision making by stakeholders (subsequent facts that can alter investment expectations) as the purpose of financial reporting (ASBJ, 2006, Section 1 paras. 1-3; ASBJ 2005a, paras.1-3). Thus, in accordance with the matching principle, the principle of cost allocation is used to calculate the profit for a period.

For stock options, prior international research has generally considered their accounting treatment based on the idea that cost recognition for labor service consumption is required (Mohri, 2013). Additionally, major accounting standards authorities, such as the International Accounting Standards Board (IASB) and the Financial Accounting Standards Board (FASB), have stipulated that recognition of stock-based compensation costs is an objective of these standards. Accordingly, recognition (cost allocation) of stock-based compensation costs can be understood as a central issue in the discussion of accounting for stock options.

However, regarding this cost allocation, there is a need for revisions to be made as predictions and estimates are revised, as with extraordinary depreciation of tangible fixed assets (ASBJ 2005a, 36 ; FASB ASC, para. 250-10-45-20). In the case of stock-based compensation, the allocation plan may need to be revised to reflect changes in the number of allocated stocks due to reasons such as mid-term retirement and modifications of the conditions. Modification of conditions refers to "a change in the terms or conditions of a share-based payment award." (FASB ASC, para. 718-20-20). This paper utilizes normative and descriptive research to examine the revision of allocation plans for stock-compensation costs, which has not been always considered in prior studies[1]. Therefore, this study examines the following points:

- What is the basic idea behind the revision of number of stock options granted to the actual numbers common to the current standards?
- Is it self-evident that each year these estimates are updated to reflect the passage of time and the changes in estimates in accounting for modifications to the terms and conditions on which stock appreciation rights were granted? (Is it self-evident that at the point the corresponding account of a cost becomes a financial liability, the procedure for adjusting the allocation plan becomes remeasuring at fair value of stock options at each reporting date?)
- When adjusting plans for stock-based compensation costs, is it preferable to use remeasuring at fair value of stock options at each reporting date for exchange of old stock options for new stock options (liquidation of investment and reinvestment) according to FASB ASC Topic 718-30, or to adjusting allocation plans

[1] Empirical and analytical studies have been conducted on the revision of allocation plans for stock-based compensation costs. In particular, in empirical studies by Brenner et al. (2000) and Acharya et al. (2000), examined the modification of conditions for the per unit fair value (particularly, downward revision of the per unit fair value). For further details, refer to Section 4.5.2.

according to ASBJ (2005b b; 2005c) and the IASB (2016) (continuance of investment)?

(2) Reviewing the current standard for stock-based compensation – Where the issues lie

1. Processes related to the adjustment of general allocation plans

1.1. Cost allocation procedures

The shared objective of financial reporting in major standards is to provide useful information for stakeholder decision-making (i.e., that expectations placed on an investment have shifted after the fact) (ASBJ 2005a, paras. 1-3; ASBJ, 2006, Chapter 1, paras. 1-3). Accordingly, the period profit calculation examines whether inputs of goods and services lead to the expected production of goods and services by comparing costs and revenues in each period (Nakajima 1979, p. 119; Paton and Littleton, 1940, p.15). This is the matching principle. This principle is characterized as a principle for the calculation of cost because it determines costs for a period of time based on their correspondence with revenue (which is an independent variable assumed to be exchanged with a third party independent of the company) (Morita, 1969, p. 40; Ueno, 1985, p. 139).

This case uses the cost allocation principle. When calculating profits for a period of time, to show gradual consumption through a firm's production activities, not all costs (cash flow or CF values) are recognized as costs immediately at the time of input of goods and services; in fact, current expenditures are recognized as costs while unrealized expenditures are deferred as assets (Paton and Littleton, 1940, p.25; Ueno, 1985, pp. 135-136).

1.2. Processes relating to the adjustment of cost allocation plans

While the cost allocation approach applies regular allocation under the current standard for stock options (e.g., the straight-line method is applied to depreciable assets), there are in general [2] three techniques for revision of forecasts and estimates: (a) the retrospective approach, (b) the prospective approach, and (c) the catch-up approach (FASB 2000, paras. 89-100. In (a), costs are adjusted retrospectively, leading to revision to costs made in all previous periods. In (b), all revisions to costs are made in the current period and thus, are recorded immediately and in full. In (c), the revised value is allocated across the remaining allocation period (FASB 2000, paras. 89-100.

2. Current standards for stock-based compensation

2.1. Provisions for adjusting stock-option allocation plans

The treatment of the above estimates during revision of stock options is largely the same under the ASBJ (2005b; 2005c) and the IASB (2016). Specifically, first, as in other fields of accounting, any deviation in the number of stock options granted from the actual number is required to be corrected to the actual value, and so total cost is revised in accordance with changes in quantity ex post (ASBJ 2005b, para. 7 (2) and 51-53 ; ASBJ 2005c, p. 3 ; IASB 2016, paras. IN5 (c) and 19-20). Second, excluding their forfeiture due to non-satisfying of the vesting conditions, regardless of any change in

[2] For this framework, I refer to the discussion on adjustment of allocation plans by present value calculation in FASB (2000, paras. 89-100), following Kawamura (2001, 143-148).

the modification and cancellation or liquidation of stock options, at a minimum, labor services (and their costs) must be recognized and measured at the fair value of the stock option as of the grant date (ASBJ 2005b, paras. 55-56 ; ASBJ 2005c, pp. 4-5 ; IASB 2016, paras. IN5 (e) and BC237[3]. Then, except in cases where the unit price has depreciated, the catch-up approach shall be used (ASBJ 2005b, paras. 10-12 and 55-57 ; ASBJ 2005c, pp. 4-5 ; IASB 2016, paras. IN5 (e) and BC 237). However, while similar to these provisions, the FASB ASC (para. 718-20-35-6) considers the fundamental idea to be the exchange of new stock options for old (original) stock options.

2.2. Provisions for adjusting allocation plans involving SARs

SARs share a commonality with stock options, as first, the total cost of SARs is revised according to ex post changes (actual value) in the number of SARs (IASB 2016, para. 33 ; FASB ASC, para.7 18-30-35-1 through 3). However, there is no provision for modifications to the conditions in which stock options were granted under IASB (2016). This is because for SARs, remeasuring at fair value of stock options at each reporting date was originally reflected in the value of the stock-based compensation cost, and hence, it is understood that no special guidance is required when modifying conditions. This too is described in FASB ASC (para. 718-30-35-5).

3. The locus of the issue

This section summarizes general cost allocation plans and the approaches of their revision and confirms the adjustment of allocation plans for stock-based compensation costs under the current standards.

Table 1 International comparison of accounting treatment for modification of conditions

<table>
<tr><th></th><th>Stock Options</th><th>Stock Appreciation Rights</th></tr>
<tr><td>FASB ASC</td><td colspan="2">(c) Stock options and stock appreciation rights, new and existing, are both processed as exchanges of stock-based compensation. However, the standard finds that no special stipulations are needed for (b) stock appreciation rights, since they are remeasured at their fair value at each reporting date, the same as in IFRS.</td></tr>
<tr><td>IFRS</td><td rowspan="2">(a) Processed by the catch-up method, except where the per unit fair value has decreased.</td><td>(b) N/A[1] (Remeasured at fair value at each reporting date)</td></tr>
<tr><td>JGAAP</td><td>N/A[2]</td></tr>
</table>

1. In IASB (2016), no treatment is stipulated for the case where conditions are modified considering stock appreciation rights.

2. In Japanese accounting standards, there is no stipulation whatsoever about stock appreciation rights.

Within this, revisions to the numbers of stock options (except for modification) granted are required to be revised to actual values for both stock options and SARs with any current standards (ASBJ 2005b, paras. 7 (2) and 51-53 ; ASBJ 2005c, p. 3 ; IASB 2016, paras. IN5 (c), 19-20, and 33). However, when conditions are modified, (a) under ASBJ (2005b, paras.55-56)

[3]A change in the conditions of stock options is "an ex-post change in the conditions of allocated stock options, with the intention of changing the fair unit price of the stock option, the number of stock options, or the period over which the rational cost is recorded" (ASBJ, 2005, para. 2(15)).

and IASB (2016, paras. IN5 (e) and BC237), the catch-up approach is adopted for accounting for stock options, except for downward adjustment of the per unit fair value of the stock option granted; and (b) since SAR requires remeasuring at fair value of stock options at each reporting date even where there is no adjustment to the allocation plan, there are no provisions for modifications to the terms and conditions on which SARs were granted. Moreover, (c) for FASB ASC (para. 718-20-35-5 and 6), this is interpreted as an exchange for new stock-based compensations, for both stock options and SARs.

Thus, this paper addresses the above-mentioned research questions.

(3) The treatment of forfeiture when the vesting conditions are not satisfied

1. The characteristics of the debate surrounding stock-based compensation

Under major current standards, stock option-related costs are regularly amortized (ASBJ 2005b, para. 4 ; ASBJ 2005c, p. 2). This is because, in general, costs associated with intangible assets, labor services (general compensation costs, including retirement benefit costs), and unobservable assets such as goodwill are regularly allocated using depreciation (AICPA 1970a, para.90 ; AICPA 1970b, paras. 21-23, and 27-31 ; FASB ASC, para. 350-30-35-6). However, since stock option is incentive compensation, if common sense carries the idea that assets should increase in accordance with the additional labor services provided through this grant, then regular amortization can be interpreted as an inappropriate means of handling stock options-related costs (Balsam 1994, 59). However, on the grant date, the contracting parties agree on a labor contract, exchanging labor services for "stock option (with incentive conditions)" (ASBJ 2005b, para. 64 ; ASBJ 2005c, p.3), and a specific exercise date during the exercise period is determined from the position of the option holder as an investor (speculation) rather than as that of an employee. In such cases, changes in stock prices accompanying the provision of additional labor services will not affect the total cost. Therefore, stock-based compensation costs can be regularly allocated with the consumption of labor services.

Here, I confirm the characteristics of stock-based compensation cost allocation procedures. First, while CF backing is present under conventional cost allocation, a characteristic particular to the allocation procedure for stock options-related cost is that no cash expenditure occurs in a series of transactions. Opinions are, therefore, divided as to the date of the stock option value (or value of labor services) that should be taken as the total allocation value.

Second, the results expected from the agreement of a stock-based compensation contract are not changes in stock prices (i.e. financial investment) but rather the acquisition of CF (i.e. business investment) from the company's autonomous business efforts using such compensation plans. Therefore, stock option-related costs, as with general compensation transactions, to correspond to revenues in each period (rather than the immediately record of their full value) can be derived as costs accompanying labor service expenditures (Paton and Littleton 1940, p. 15).

2. Changes in the number of stock option granted after the grant date: The handling of forfeiture when the vesting conditions are not satisfied.

As stated, this cost allocation may be required to be adjusted when estimates are revised (FASB ASC, para. 250-10-45-20). The first adjustment to the stock-based compensation cost allocation plan is to reflect changes in ex-post quantity in the allocation plan (ASBJ 2005b, para. 7 (2) and paras. 51-53 ; ASBJ 2005c, p. 3. This is because stock options are generally granted to multiple employees, some of whom may leave the company in the middle of the vesting period or fail to meet the vesting conditions. Therefore, even where the number of vested stock options is estimated from the starting grant date, the numbers, including that of employees, may change the fact of de fact (ASBJ 2005b, paras. 7 (2) and 51-53; ASBJ 2005c, p. 3. However, the event occurs after the recording of cost has begun. Therefore, a debate has arisen in accounting as to whether changes in the number should be reflected ex-post in the total stock-based compensation cost (amount of cost per employee multiplied by number of employees), and if it is to be reflected, at which point in time this is to be done.

First, the view that changes in the number of stock options after the grant date should not be allocated at all is based on the following idea. On the grant date, the parties to the contract are considered to have entered into an economically equivalate transaction (including the possibility of leaving the company partway through or forfeiture the conditions) (ASBJ 2005b, paras. 44 and 49-50; ASBJ 2005c, p. 2. Thus, the value of labor services and the value of the stock option are equivalent on the grant date, and changes in the stock price and in numbers after the grant date can be interpreted as unrelated to the total cost[4].

However, if the number of grants is used for determining the amount of the cost, and where the cost continues to be recorded without reflecting mid-term retirement, that total cost can be interpreted as having deviated from the true value. In other areas of accounting, since adjustment to the actual number of stock options is generally required where deviation from the true value occurs, even if the total value of stock-based compensation costs is measured on the grant date, the total cost may be revised in accordance with ex-post changes in the numbers (ASBJ 2005b, paras. 7 (2) and 51-53 ; ASBJ 2005c, p. 3) .

There are three specific measurements of cost. First, the following accounting treatment can be derived based on the retrospective approach. stock options are granted to employees as compensation (compensation for labor delivering shares in the future). However, stock options will have value as a reward only after the vesting conditions are satisfied. Accordingly, stock options are not considered commensurable to the value of labor services where their conditions are not vested. Therefore, in accounting, the value of stock-based compensation costs can be recorded using the number of vested or exercised stock options, and when forfeiture occurs, it is possible to adjust retroactively the costs recorded previously to conform to the actual value.

[4]However, the method of calculating the cost using the number of expected rights vested at the grant date is not rejected.

However, even if a stock option does not exercise due to forfeiture when the vesting conditions are not satisfied, it is undisputed that the company received and consumed labor services. In such cases, that fact which occurred in the past, should be faithfully recognized as a cost and even if the conditions are not vested in the future, should not be revised easily. In accordance with this idea, when changes in numbers of stock options occur after the grants of stock options, the value of cost recorded in the past is not retroactively revised. However, an accounting treatment (prospective approach or catch-up approach) can be derived to revise the amount of costs in the period in which an unforeseen event occurs or thereafter (ASBJ 2005b, paras. 7 (2) and 51-53 ; ASBJ 2005c, p. 3). Current standards have adopted the prospective approach to reflect that labor services have been received and consumed in financial statements.

(4) Consideration of accounting treatments for modifying the conditions of stock-based compensation

1. Modification of stock-based compensation

In response to changes in numbers that may occur even where the above allocation plan proceeds successfully, for stock-based compensation, the vesting conditions established on the grant date may be modified to improve employees' motivation to work (ASBJ 2005b, para. 54 ; IASB 2016, paras. 26 and BC222). For example, since the incentive to work is largely reduced where the stock price falls sharply after the grant date and the probability of the exercising of these options decreases, the exercise price can be reduced to rectify this (ASBJ, 2005,b para. 54; IASB 2016, paras. 26 and BC222).

Continuing the previous allocation plan when this modification occurs, the allocation of stock-based compensation costs over the period will deviate from the actual situation of stock-based compensation. Hence, if a change is made to the conditions, a revision of the allocation plan will be required.

Contrary to stock options where the current standards explicitly are required when applying to alter conditions, there is no requirement in applying to SARs when conditions are modified. This may be related to the fact that remeasuring at a fair value of stock options at each reporting date is performed for SARs (FASB ASC, para.718-30-35-1 through 3). Several studies on accounting treatments for stock options, such as Balsam (1994), consider accounting for stock options reconciling accounting for economically equivalent transactions (transactions of SAR). I, therefore, discuss whether remeasuring at fair value of stock options at each reporting date can be a powerful theory when terms are altered.

2. Accounting treatments 1: Adjustment of allocation plans based on remeasuring at fair value of stock options at each reporting date

2.1. The rationale for remeasuring at fair value of stock options at each reporting date for SARs

Even in many practical works, stock option is said to be a type of incentive compensation. In such cases, it is also understood that the increase in costs should be recognized using proxy values such as stock prices to represent the provision of additional labor services accompanying the grant of stock options (Balsam 1994, 59). Behind this lies the idea that changes in the value of labor services are linked to changes in stock prices.

2.2. A logic for revising allocation plans through continuous mark-to-market valuation

Under accounting standards for SAR, stock-based compensation is a type of incentive compensation, and changes in the value of labor services are regarded as linked to changes in proxy values such as stock price (IASB 2016, para. 33 ; FASB ASC, para. 718-30-35-3). Following the above, because the total amount of stock-based compensation costs is remeasured at fair value of stock options at each reporting date, it can be understood that if a modification takes place, no special guidance for the adjustment of allocation plans is required at the date of the modification if the adjustment is made using fair values (FASB ASC, para. 718-30-35-5).

2.3. An argument for business investments (inventories) that refer to market value but do not use fair value

As noted above, stock-based compensation is granted as a consideration for labor services (as part of business investment). Conversely, the accounting treatment obtained in the previous section is generally used for financial investments.

Therefore, I confirm adjustments to allocation plans about inventory transactions that refer to market value, out of business investments. The expectation placed on investment in inventory, as with financial instruments, is to achieve greater results by selling inventory on the marketplace (Paton and Littleton 1940, p. 81 ; ASBJ 2008, para. 37). Inventories are the same as financial instruments as they are held for the purpose of sale. However, since they are sold on a variety of markets with different dynamics, market players, and expectations, the company is able to manipulate prices through its own sales efforts even if there is no guarantee that a transaction will be concluded (Yoneyama, 2003, pp. 65-66; ASBJ 2008, paras. 11 and 51). Therefore, it is understood that the numbers are adjusted to the true value when the acquisition cost is deferred, and the inventory has been sold (when the physical use and benefit has completely expired) (ASBJ 2008, para. 41).

However, the current standards for inventories in many countries use the lower of the cost or market method, and when per unit prices fall due to damage or reduced quality, or when numbers are reduced due to theft or other reasons, book values are often adjusted to match market value (Paton and Littleton 1940, pp. 79-81; ASBJ 2008, paras, 36-37 ; Yoneyama, 2003, p. 71). Therefore, I review adjustments (that previous studies have yet to examine per unit costs) to allocation plans when environmental changes occur in inventories.

For inventories, when the market value no longer reaches the book value (e.g., where the value has fallen due to market valuation or physical damage), a procedure is applied to reduce the book value according to market value (Paton and Littleton 1940, pp. 79-81 ; Yoneyama, 2003, p. 71 ; ASBJ 2008, para. 37). From the asset and liability view, this is primarily done to preserve the recoverability of the book value of the items shown on the balance sheet, while if examined from the revenue and expense view, it is to correctly calculate profit and loss for the period following the adjustment of the allocation plan (Yoneyama, 2003, pp. 75-76 and 79-80).

In such cases, even if the transaction emphasizes the market value, there will be no remeasuring at fair value of stock options at each reporting date (particularly the upward revision of prices per unit). Accordingly, stock

options—a form of business investment—do not invariably require adjustment of cost at each reporting date, even if the corresponding account for stock-based compensation cost is a liability.

3. Accounting method 2: The exchange of old stock options for new stock options

3.1. Provisions for altering in conditions of stock option-related costs under US standard

Next, I consider the modifications in conditions of stock option under FASB ASC as an alternative accounting treatment. Specifically, the FASB ASC is the same as the ASBJ (2005) and IASB (2016) because, at a minimum, labor services (and their consumption) must be recognized as measured at the fair value on the grant date of the stock option, regardless of any modification or the cancellation or liquidation of the stock option grant (excluding forfeiture when the vesting conditions are not satisfied). Further, FASB ASC treats a change in conditions as an exchange of a new stock option for the original stock option. Below, I consider the significance of this exchange.

3.2. Liquidation of investment and mimicking reinvestment: In relation to the fresh-start method (fair value pooling) for business combinations

First, I can derive the idea that exchanging new stock options for the original stock options leads to the liquidation of, and subsequent reinvestment in, the investment made. Moreover, fresh-start method for business combinations is similar to this idea because the fresh-start method considers business combinations to liquidate the previous control relationship and create a new company (Wilcox 1950, p. 106 ; Wyatt, 1963, p. 82). Thus, the net assets of all the parties in the business combination are recognized at fair value as the starting point of the "new" company, since the company emerging from the business combination is expected to have changed substantially from the company prior to the business combination (Wilcox 1950, p. 106 ; Wyatt, 1963, p. 82). Within the fresh-start method, this is the concept of fair value pooling.

Following this discussion, if labor services are received based on new stock options with new vesting conditions, those labor services can also be interpreted as being different from those previous, and stock-based compensation cost must be allocated over the period on a new accounting basis (allocation plan). In such cases, even if the total allocation of stock-based compensation costs is revised downward from the previous allocation, a new allocation of stock-based compensation costs is made for the period based on the total allocation; this would be a remeasurement made using the fair value on the date of the modification (either stock option or labor services, whichever is more reliable). In other words, this is the catch-up approach.

3.3. Accounting method 3: Continuance of investment at the date of the modification (the logic of current standards)

Conversely, the current standards can be interpreted as being based on the idea that investment continues even if stock options are exchanged. This can be confirmed using a business combination through an exchange of stocks (pooling-of-interests method) (AICPA 1970a, para. 12), as in a business combination by exchange of stocks (between a surviving company and the dissolving company), the

surviving company acquires all the stocks of the dissolving company in exchange for its own stocks. The stockholders of the dissolving company become stockholders of the surviving company, enjoying the risks and returns of the combined company (AIA 1950, paras. 2-3 ; AICPA 1970a, para. 28 ; Coleman 1970, 96). Accordingly, it can be interpreted that even if a share exchange is conducted between the surviving company and the dissolving company, the expectation for the investment remains unchanged, and the company for which expectations are unchanged survives (AIA 1950, para.5; AIA 1957, para.9; AICPA 1970a, paras. 12 and 28).

Applying this to transactions for stock options yields the following: in a business combination through the exchange of old (original) stock options for new stock options, the new stock options acquire all the employees' labor services in exchange for the old stock options (where the per unit price of the new stock options is higher than that of the old stock options), and so the old stock options enjoy the receipt and consumption of the labor services accompanying the allocation of the new stock options. In such cases, even if the old stock options are exchanged for new ones, the expectations placed on an investment are unchanged and can be interpreted as a continuance of stock option investment with expectations remaining unchanged. Therefore, the exchange of old stock options for new stock options may be viewed as similar to a modification under ASBJ (2005) and IASB (2016).

Based on this idea, the next section analyzes the logical necessity of accounting for modification (where we assume investment is continued).

4. Adjustment of allocation plan for stock-based compensation costs based on the logic of amortizable assets

4.1. Procedures for the allocation of unobservable assets

Generally, the costs associated with unobservable assets such as intangible assets, labor services (general compensation tractions, including retirement benefit costs), and goodwill are allocated regularly using this depreciation (AICPA 1970a, para.90 ; AICPA 1970b, paras. 21-23, and 27-31 ; FASB ASC, para.350-30-35-6). The expected outcome of holding these unobservable assets is the acquisition of CF from the company's own business efforts using those assets (ASBJ 2005a, para. 60; ASBJ 2006, Chapter 4, para.57). Correspondingly, the physical utility of this type of asset is understood to gradually decrease and eventually be entirely consumed. To reflect this in accounting treatments, the current standard requires regular amortization corresponding to earnings in a given period (FASB ASC paras. 350-30-35-1 and 2).

4.2. Accounting treatment for modification under Japanese and international financial accounting standards

So, what would be the process for adjusting this allocation plan under current standards? As stated, the ASBJ (2005b, paras.10-12 and paras. 55-56) and the IASB (2016, paras. IN5 (e) and BC237) are broadly similar in their treatment of modification. Specifically (excluding forfeiture when the vesting conditions are not satisfied) regardless of a modification, or the cancellation or liquidation of the stock options, at a minimum, labor services must be recognized measured at fair value on the grant date (ASBJ 2005b, paras. 55-

56; ASBJ 2005c, pp. 4-5). The following revision procedure (excluding situations where the per unit price has fallen; this is addressed using the catch-up approach) is then performed (ASBJ 2005b, paras. 10-12 and 55-57; ASBJ 2005c, pp. 4-5).

First, regarding per unit price, the ASBJ (2005, paras. 10(1) and 55) requires that when a per unit price is adjusted due to a modification, the previous allocation plan of stock options be continued for upward adjustments, and the increase due to the modification be recorded as additional per unit price multiply by the number of stock options. In cases of downward revision, no special revision procedure is used, and the previous allocation procedure will continue (ASBJ, 2005b, para. 10(2); ASBJ 2005c, p. 4 ; IASB 2016, para. B44(a)). Second, a modification leading to an adjustment of the numbers of stock options granted can be interpreted as having been performed with the expectation of an effect in the future, and so the original allocation plan is continued, with the revised amount reflected over the remaining period (ASBJ, 2005b, paras. 11 and 57; ASBJ 2005b, 4; IASB, 2016, para. B43). Third, if the allocation period changes due to modification, the total amount of allocation plan anticipated prior to the modification is recorded over the new remaining period (ASBJ, 2005b, para. 12; ASBJ 2005b, pp. 4-5; IASB, 2016, paras. B43-44).

4.3. Adjustment of allocation plans where expectations placed on the investment are unchanged

As stated in 4.1, the logic of depreciation can be useful in analyzing the allocation of stock-based compensation costs over time. In such cases, discussion of the procedure for revising estimates of depreciable assets could also serve for the revision of allocation plans. There are broadly two types of revision procedure: (a) a revision required where the purpose for holding an asset does not change (shortening of useful life) (FASB ASC, paras. 350-30-35-9 through 13), and (b) a revision required where the purpose for holding an asset is changed (impairment) (Yoneyama, 1999, p. 380). To anticipate the conclusion, it is believed that stock-based compensation does not align with procedure (b) because, as with retirement benefits, even if the estimate is revised, the expectation that compensation (equivalent value) will be paid to employees in return for the labor services received from employees does not change (Yoneyama, 1999, pp. 380-381; FASB ASC, para. 250-10-45-20). Based on this idea, I analyze revision procedure (a).

4.4. Adjustment of allocation plans (allocation periods) stock-based compensation cost based on the logic of amortizable assets

In an allocation plan for amortizable assets, (a) the observable acquisition cost (total cost of allocation plan) is allocated as cost using a mechanical and regular (b) pattern (assumption), and the cost (depreciation) is recorded in the income statement for each period over its (c) useful life (allocation period) (AIA 1953, Chapter 9, para.5). In revising this plan, it is necessary to consider adjustments of the allocation period in (c), and the accompanying adjustment of the allocation pattern in (b). This is because (for amortizable assets) the total amount of allocation plan in (a) does not need to be adjusted because it is CF that has been spent and fixed in the past. Therefore, I first consider the allocation period

in (c) and associated adjustment of the allocation pattern in (b).

Traditionally, the allocation period (when the physical utility of an amortizable asset is depleted) is considered an estimable event, and costs are allocated so that the book amount reaches zero at the end of the allocation period (Yoneyama, 2003, pp. 9-16; FASB ASC, para. 250-10-45-20). Following this idea, if a revision of the useful life estimate is required, the book amount will not reach zero at the end of the allocation period if amortization continues to be based on the original useful life (Yoneyama, 2003, p. 16). Therefore, the allocation period must be re-estimated, and the allocation pattern be revised so that the book amount at the end of the new pattern of allocation becomes zero (Yoneyama, 2003, p. 16; FASB ASC, para. 250-10-45-20).

Here, three more specific approaches can be considered. However, a company intentionally alters the initial vesting conditions at the date of the modification. Thus, the allocation plan is believed to be correct up to the date of the modification. Therefore, the retrospective approach, which revises the allocation plan previously, can be rejected, and the prospective approach or the catch-up approach can be derived. Then, with the support of adjustment of estimates (recognition of prior service costs and actuarial gain or loss) for retirement benefits—discussed next—the prospective approach can be used under the idea that the adjustment of the estimate should be recognized as swiftly as possible (based on the conservatism), and the catch-up approach (an allocation period spanning the remaining allocation period) can be used if the modification leads to an increase in employees' motivation to work in the future.

5. Adjustment of allocation plans (total amount of allocation plan, i.e., per unit price and number of stock options granted) for stock-based compensation costs based on the logic of retirement benefits

Unlike in the case of amortizable assets, the total amount of allocation plan is not fixed in transactions of stock options. The same is true for SARs and retirement benefits, which are net-cash-settled stock-based compensation (AIA 1956, para.4 ; AICPA 1966, paras. 11 and 13 ; IASB 2016, para. BC241). Nevertheless, in AIA (1956, para. 4), uncertainties regarding the determination of pension costs are not so great as to prevent cost allocation, and periodic allocation of these costs is discussed.

Hence, the estimate can be revised even for total amount of allocations where the allocation plan was not revised during the amortizable assets phase. Generally, the total amount of allocation plan (acquisition cost) is calculated as "per unit price multiply by number (number of employees)" (AICPA 1966, para. 2). Therefore, continuing the discussion in the previous section, taking retirement benefits, a compensation transaction for which the total amount of allocation is not fixed, this section discusses revisions to estimates of total allocation (per unit price and number).

5.1. Adjustment of allocation plans for retirement benefit

Generally, although it may be assumed that the pension plans will continue indefinitely, the most important rule to be observed in the allocation procedure is that the total amount of allocation reaches zero at the end of the allocation period (AIA 1956, para.5 ; AICPA 1966, para. 12 ; FASB ASC, para. 250-10-45-20). Thus,

if not only the allocation period[5] but also the total amount of allocation is adjusted, the revision to the estimate is reflected in the periodic profit and loss as actuarial gain or loss (AICPA 1966, para. 25 and Appendix A). Moreover, where adjustment is made to the level of retirement benefit similar to modification, the amount of that adjustment will be recorded as prior service cost (AICPA 1966, para. 17). However, even based on this assumption, there is no unequivocally determined accounting process, and as with adjustments to the allocation period, this can lead to the prospective approach (delayed recognition) and the catch-up approach (immediate recognition) (AICPA 1966, para. 47; Yoneyama, 1999) [6].

Furthermore, adjustments of the allocation plan are required where retirement benefit obligations (of equal value to the retirement benefits allowance in this case) are reduced due to mid-term retirement (while maintaining a separate allowance for each individual, as with stock-based compensation) (AIA 1956, para.8). Specifically, in the case of general retirement, the difference between the reduction in accrued pension cost and the amount paid to employees (cash expenditure) is handled using the prospective approach as a reversal of retirement benefit costs. This can be interpreted as a correction to the actual amount of the number, as in other fields of accounting.

5.2. Revisions to the number of stock options

I first analyze the number of stock option based on the discussion in the previous section. With regard to numbers of stock options, as set out in Section (3), and not limited to modifications, any deviation between the number set during allocation planning and the actual number of stock options requires revision to reflect the actual amounts, and so the total amount of allocation may be revised to adjust the number of stock options granted accompanying modifications.

Here, following Section 3, there are three specific approaches of adjustment. However, a company intentionally alters the initial vesting conditions on the date of the modification. T recognizes that the allocation plan is correct up to the date of the modification. Thus, the retrospective approach, which adjusts the previous allocation plan, can be rejected, and the prospective approach or the catch-up approach can be derived.

5.3. Adjustments to the per unit price of stock options

By contrast, how do we regard the per unit price of stock options? If, despite revising the estimate of total amount of allocation (total stock-based compensation costs), this fact is not reflected in the periodic profit and loss, the book amount of stock-based compensation costs will not reach zero at the end of the allocation period. The per unit price within the total amount of allocation can therefore be adjusted using the three approaches described above. However, since a company intentionally alters the initial vesting conditions on the date of the modification and the allocation plan is assumed correct up to the date of the modification, the

[5] Moreover, in AIA (1956, para. 5), the candidate allocation periods proposed for accounting treatment for pension plans include the remaining service period for eligible employees when the pension plan is adopted and the total period of the pension plan and the plan that succeeds it (an unlimited period).

[6] Moreover, FASB/ASC and the ASBJ (2016) require deferred recognition, while IASB (2011) requires immediate recognition.

retrospective approach, which adjusts the previous allocation plan, can be rejected, and the prospective approach or the catch-up approach can be derived.

Then, with the support of revision to estimates (recognition of past service costs and actuarial differences) for retirement benefits, described later, the prospective approach can be used under the idea that the revision of the estimate should be recognized as swiftly as possible (based on a conservative approach), and the catch-up approach (an allocation period spanning the remaining allocation period) can be used if the modification leads to an increase in employees' motivation to work in the future.

Here, under the current standards, there is a shared, asymmetric treatment of increases and decreases in cost; that is, upward adjustment (increases) of per unit prices results in the recording of additional costs, while for downward adjustment (decrease) of per unit price; existing costs are not reduced and periodic allocation is carried out as before (ASBJ 2005b, p. 4). It has been argued that this is not acceptable considering stock-based compensation to be incentive compensation, as exemplified by Balsam (1994) and others. However, using the logic of retirement benefits, we discussion this point as follows.

Since stock-based compensation is incentive compensation, modifications of such compensation are made to destroy the incentives that exist in the original contract and to increase the employees' motivation to work in the future (Brenner et al. 2000 ; Hume and Tokic 2005, 63) [7] . In such cases, a downward adjustment of total stock-based compensation cost during modification should not generally be done because it leads to rewarding employees for poor performance, which in turn leads to signs of future financial difficulties or high volatility (Acharya et al. 2000 ; Hume and Tokic 2005, 64 and 66). Moreover, IASB (2016, para. BC237) also points out that downward revision of the total amount of stock-based compensation costs must be allowed to prevent profit manipulation by modification of conditions. Correspondingly, the allocation plan can be adjusted only in cases of maintenance of the status quo or that of upward adjustment of the per unit price in the total amount of allocation same as ASBJ (2005b; 2005c) and IASB (2016).

(5) Conclusion

The main conclusions are as follows:

1. Because adjustment of numbers to actual amounts is also performed in other fields of accounting, the number of stock option will be adjusted even when there are no specific modifications. The reason is that in adjusting allocation plans of stock-based compensation cost, an adjustment procedure similar to that of the current standards can be considered as the widely accepted theory. However, in so doing, the retrospective approach is not adopted, to faithfully represent the fact of the receipt and consumption of labor services.
2. Even if the corresponding account for the cost is a liability, adjustment using remeasuring at fair value of stock options at each reporting date is not self-evident.
3. In IASB (2016), accounting treatment for modification for stock appreciation rights that is not self-evident as described in 2, is stipulated so that it is self-evident.

[7] In Gilson and Vetsuypens (1993), rights-holders were said to prefer stock option price revisions as they reduced the incentive for taking on high-risk projects in an effort to increase shares.

Moreover, FASB ASC stipulates an accounting treatment by deeming modification as an exchange of new and old stock options, even though the nature of the investment is unchanged. Conversely, under JGAAP, the procedure for modifying the allocation plan for stock-based compensation (regardless of whether the corresponding account of costs is liability or equity) (accounting for adjusting the number and modification) can be a powerful theory.

This paper examined the adjustment of allocation plans for stock-based compensation costs (accounting of changes in the number of issued stock options in the general phase, except in the case of modification and in the case where conditions are modified). This is an allocation issue that has not been well investigated before using normative and descriptive research. Particularly, the paper uses allocation methods and so forth in other accounting fields as a reference framework. The discussion in the introduction is regarding 1) whether accounting treatment of changes in the number of issued stock options in the general phase (except in the case of modification) and where conditions are modified, impacts stock prices and truly provides useful information for investment decision-making (whether it is functioning as originally envisaged); and 2) the kind of financial impact and consequences that such accounting treatment brings to stakeholders (how would corporate behavior change with the application of the accounting treatments discussed here). However, the discussion here does not necessarily reveal clear answers to these questions. Examination of these questions using empirical and analytical methods is, therefore, a subject for further research.

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(Received: December 16, 2020)
(Accepted: March 21, 2021)

Quality of cost information utilized in cost management: Evidence from a survey of Japanese factories

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Abstract

The purpose of this study is to clarify the characteristics of cost information utilized in cost management. For this purpose, the framework of cost information quality was applied to enable comprehensive and systematic measurement of the characteristics required for cost information. The relationship between each characteristic (quality) and the degree of use and satisfaction of cost information in cost management was then clarified by conducting a questionnaire survey in the factory. The results showed that (1) representational and contextual quality is positively associated with the degree of use of cost information, but no relationship is found for intrinsic quality; (2) all quality dimensions are associated with satisfaction with cost information; and (3) the moderating effect of representational quality is confirmed for the relationship between intrinsic quality and satisfaction. These findings indicate the validity of prioritizing expressive and contextual quality over the intrinsic quality dimension in the utilization of cost information, and that intrinsic quality is a necessary but not sufficient condition.

Keywords Cost Information, Cost Accounting, Information Quality, Cost Management, Questionnaire Survey

(1) Introduction

The usefulness of cost information in cost management has been discussed for some time, and many studies have been conducted. Recent studies on cost information have focused on the issues of indirect cost allocation and the accuracy of cost information (Brierley, 2008, pp.61-63). The accuracy of cost information refers to the degree to which cost information realistically reflects management and production realities. Accurate cost information can be provided only through highly sophisticated cost accounting that appropriately maps daily activities and causal relationships (Drury, 2015, pp.86-87; Kataoka, 2011, pp. 2-7). It has been pointed out that the usefulness of cost information in modern manufacturing environments has decreased due to the low accuracy of traditional calculations; therefore, studies to clarify the effects of accurate cost information with precise allocation and accurate cost information have accumulated (Johnson and Kaplan, 1987; Kataoka, 2011, pp.2-5). However, the results of studies on the effects of sophisticated cost allocation and accurate cost information, such as the degree of

use and satisfaction in cost management, are not consistent (Gosselin, 2006, pp.662-663). Moreover, sophisticated costing, such as ABC, is not widely used in practice (Gosselin, 2006, pp.649-656).

Some previous studies indicate the importance of information characteristics other than accuracy. For example, Brierley (2008) found various characteristics required for cost information, such as understandability and completeness, from field surveys. This suggests a gap between research and practice in previous studies, which have focused on accuracy. Pizzini (2006) also showed that the level of detail and frequency of reporting affect the usefulness of cost information. These studies suggest that increasing the accuracy of cost information does not directly relate to the usefulness of cost information in cost management. In other words, the sophistication of cost allocation and accuracy of cost information, which have been the focus of previous studies, may not fully explain the effectiveness and usefulness of cost information.

Previous studies have some limitations. First, there is a lack of empirical evidence on the effects of information characteristics other than accuracy. It is not sufficiently clear how properties other than accuracy contribute to cost management as opposed to accuracy, for which a wealth of evidence has accumulated. Second, in studies on characteristics other than accuracy, the relationship between such characteristics is unclear. Some characteristics, such as completeness, detail or relevance, and decision usefulness, may have inclusive or causal relationships. However, since studies are based on various theories and dependent variables, it is difficult to organize the relationships between the characteristics discussed in previous studies (Iwasawa, 2020, p.52). Third, it is necessary to focus on the use of cost information at the individual manager level. Many previous studies have been based on surveys at the firm or plant level, even though it has also been suggested that even in the same organization, the requirements for cost information may differ depending on contextual factors and important purposes of use. (Abernethy et al., 2001; McGowan and Klammer, 1997; Schoute, 2009). Since some argue that satisfying the requirements of each manager is important for the effective use of accounting information (McGowan and Klammer, 1997), it is desirable to focus initially on the individual level.

Therefore, the purpose of this study is to elucidate the characteristics of cost information utilized in cost management, with a focus on the individual manager level. To achieve this purpose, this study has two features. First, based on the "cost information quality" framework (Section 2), we measure the characteristics of cost information and develop hypotheses (Section 3). This framework makes it possible to systematically measure the characteristics required for cost information; thus, we intend to explain the relationship between cost information and its utilization, for which there has been no consensus on the results in previous studies. Second, we conduct a questionnaire survey of production department managers in two firms (Section 4) to test our hypothesis (Section 5). In this way, we intend to clarify the relationship between each characteristic of cost information and its utilization at the individual level based on empirical evidence.

(2) "Cost Information Quality" Framework

In order to apply the "Cost Information Quality" framework (Iwasawa, 2020), we will first explain the concept of "information quality" and the "four-dimensional model of information quality" which the framework relies on, according to DeLone and McLean (1992), Sekiguchi (2013), and Yakuwa (2010). Information quality, which is a concept of information systems theory, is defined as "fitness for use of information" and refers to the degree to which the management information provided meets the requirements. This concept has attracted attention because information systems theory has focused too much on technical aspects. Research on technological models alone cannot fully explain the usefulness of management information; therefore, it is important to pay attention to the users of information. In order to evaluate and measure information quality, Wang and Strong's (1996) "Four-Dimensional Model of Information Quality" exhaustively and systematically presents the sub-characteristics that constitute information quality. The model presents the constituent characteristics of information quality in an exhaustive and systematic manner based on a large-scale survey. This model makes it possible to measure and evaluate information quality, which is an abstract concept. Specifically, the model shows that information quality is composed of four quality dimensions, and it is possible to measure the quality of information by confirming whether the information being used meets the requirements of the sub-characteristics that constitute each quality dimension.

Relying on this four-dimensional model of information quality, the framework of "Cost Information Quality" presents the characteristics required for cost information. According to the framework, cost information is required to have nine characteristics in four dimensions: intrinsic quality dimension (accuracy and objectivity), accessibility dimension (ease of operation and accessibility), representational quality dimension (ease of understanding and conciseness), and contextual quality dimension (relevance, completeness, and timeliness) (Table 1).

Table 1 Cost information quality, component dimensions, and sub-characteristics

Sub-characteristics	Examples of Prior Research
Intrinsic quality dimension	
accuracy	ABC studies and many others
objectivity	Myers et al. (2017)
Accessibility quality dimension	
ease of access	–
ease of operation	–
Representational quality dimension	
understandability	Brierley (2008)
conciseness	Cardinaels (2008)
Contextual quality dimension	
relevance	Mia and Chenhall (1994)
completeness	Pizzini (2006)
timeliness	Chenhall and Morris (1986)

Iwasawa (2020)

Cost information quality refers to "the degree of conformity of the cost information being used with the requirements for cost information." Based on the awareness of the problem that it is unclear what characteristics are required for cost information and why, Iwasawa (2020) built a framework showing the characteristics required for cost information, empirically confirmed its validity through field studies, and confirmed that the required

characteristics differ depending on the purpose of using cost information. In addition to empirically confirming the validity of the framework through field studies, we confirmed that the required characteristics differ depending on the purpose of the use of cost information.

This study applies the framework of cost information quality to measure the characteristics of cost information for three reasons. First, it enables us to comprehensively and systematically measure the required characteristics of cost information. As already mentioned, although there are a wide variety of points that have been noted in previous studies regarding the characteristics required for cost information, the theories and explanatory variables used in these studies are inconsistent, making it difficult to integrate the research results. In this study, we apply the framework, which is based on the main concepts of information systems theory and has been empirically verified by field studies, to solve the research problem. Second, it is possible to measure the characteristics of cost information for each purpose of use. It has been shown that the degree of characteristics required for cost information varies depending on the purpose of use (Schoute, 2009); however, previous studies did not take this into consideration. Since the framework empirically shows that the required characteristics differ depending on the purpose of use, it makes it possible to conduct research for each purpose from the viewpoint of users. Third, the framework is robust as a measurement framework. Since it relies on the major models of information systems theory, research on measurement methods for the concept has been conducted, such as Lee et al. (2002) and other studies on the measurement of concepts. By using these studies, it is possible to conduct research based on concept measurement with higher validity.

(3) Developing a Hypothesis

1. Constituent dimensions of cost information quality required for cost management: Focusing on intrinsic, representational, and contextual quality

Among the four quality dimensions of cost information quality, this study focuses on three of these quality dimensions: intrinsic, representational, and contextual. This is because for planning and control (P&C) purposes, including cost management, intrinsic, representational, and contextual quality dimensions are required, and the accessibility quality dimension is less important (Iwasawa, 2020). Unlike management decision making purposes where managers use the information on an ad hoc basis, cost information for P&C purposes is provided through periodic reports, such as monthly reports; therefore, easy accessibility is not required. In addition, ease of operation is not important because there is seldom any need for extracting specific figures from cost information for P&C purposes.

Therefore, based on empirical evidence from previous studies that cost management has requirements regarding the intrinsic, representational, and contextual quality dimensions, this study measures the seven sub-characteristics that make up the three quality dimensions. According to the definition, for each quality dimension, if the level of the constituent sub-characteristics is high, it is expressed as "high quality." For example, in terms of the intrinsic quality dimension, if the information provided satisfies accuracy and objectivity, which are the sub-characteristics of the intrinsic

quality dimension, it is expressed as “high intrinsic quality.”

2. Degree of use and satisfaction with cost information in cost management: Explained variables

For the following two reasons, we focus on the "degree of use" and "satisfaction" of cost information in cost management as variables to measure its utilization in cost management. The first reason is its importance. According to DeLone and McLean (1992), in information systems theory, these two variables, namely, degree of use and satisfaction, have been widely used as explained variables to measure the success of information systems and the impact of management information on users. This is because of the problem that the usefulness of a system, regardless of how technologically superior, is low when there is a cognitive gap between information providers and users. Management information that is not often used and has a low level of satisfaction in the field will not produce results and contribute to the organization. Therefore, it is important to pay attention to these variables in cost information, which is part of management information. It has been pointed out that the value of accounting information depends not on its sophistication as a method, but on how it is used and interpreted (Hall, 2010). In fact, many previous studies on cost information have focused on this issue (e.g., Foster and Swenson, 1997; Schoute, 2009); however, the degree of satisfaction with sophisticated allocation calculations varies among users, and it is not clear what characteristics are related to these variables.

Second, it is anticipated that the characteristics of information associated with each of these variables may differ. It is true that the degree of use and satisfaction level are related, and there is a certain correlation between them; however, in management systems theory, it has been shown that the factors that affect each variable are different (DeLone and McLean, 1992, pp.66-69). For example, in a situation where management information must be used, it is insufficient to measure only the degree of use. Therefore, it is necessary to measure both variables ("degree of use" and "satisfaction") because it is expected that the characteristics related to the degree of use and degree of satisfaction are not necessarily the same for cost information, as described later.

3. Relationship between the component dimensions of cost information quality and the degree of use and satisfaction of cost information in cost management

We discuss the relationship between the intrinsic, representational, and contextual quality dimensions and the degree of use and satisfaction of cost information.

As for the representational quality and the contextual quality dimensions, it is presumed that these dimensions are closely associated with both the degree of use and satisfaction of cost information. It has been observed that the understandability of costing is enhanced to encourage its use in manufacturing plants (Hiromoto, 1988; Merchant and Shields, 1993). If plant managers cannot understand the factors behind the numerical values, they will not make the next improvement. In addition, if the amount of information is large and the conciseness of accounting information is low, it will have an adverse effect on the decision making of users (Chewning and Harrell, 1990).

Furthermore, with regard to the context quality dimension, the importance of providing appropriate cost information according to the user's task has been pointed out for a long time, as in the maxim "different costs for different purposes." Since the usefulness of cost information in a range different from that of one's accounting responsibility is low, reporting cost information in an appropriate range, mesh, and at an appropriate time leads to its usage and satisfaction (Arai et al., 2010; Chenhall and Morris, 1986; Pizzini, 2006).

The intrinsic quality dimension is expected to have a close relationship only with the degree of satisfaction of the cost information and a weak relationship with the degree of use. Since many cases have reported that cost information with low accuracy leads to users' distrust, that is, values that deviate from the senses of the manufacturing site (Abernethy et al., 2001), it is closely related to the degree of satisfaction. As for objectivity, there is empirical evidence that informal cost information, which is not monitored by the IT department and is provided by individual employees, is less objective and verifiable, and thus trust in cost information is reduced (Myers et al., 2017). Thus, objectivity is also assumed to be related to satisfaction.

However, the relationship between the intrinsic quality dimension and the degree of use is less relevant. The intrinsic quality dimension, as defined, is a dimension related to the numerical data of the information and is less related to the ease of use of the information than the other quality dimensions. For P&C purposes, including cost management, cost information is often connected with performance evaluation, and managers are responsible for costs. Therefore, it is difficult to assume that they do not use cost information to improve the figures even if they are aware of the problems of accuracy and objectivity to some extent. Therefore, we propose the following hypotheses:

Hypothesis 1: The representation and contextual quality of cost information is positively associated with the degree of use of cost information in cost management.

Hypothesis 2: The intrinsic, representational, and contextual quality of cost information is positively associated with the satisfaction of cost information in cost management.

4. Moderating effects of representational and contextual quality dimensions on the relationship between intrinsic quality dimensions and satisfaction

In this study, we expect a moderating effect of representational and contextual quality dimensions on the relationship between the intrinsic quality dimension and satisfaction with cost information. In other words, the relationship between the intrinsic quality dimension and satisfaction differs depending on the level of representational and contextual quality.

Previous studies have pointed out that accurate allocation calculations and highly accurate cost information do not necessarily directly lead to satisfaction (Brierley, 2008; Schoute, 2009; Shields, 1995). With regard to this issue, when accuracy and other characteristics are traded off, cases have shown that other characteristics are often prioritized over accuracy. For example, the sophistication of indirect cost allocation makes the focus of cost management unclear and hampers the

understandability of cost information in the production line (Hiromoto, 1988; Merchant and Shields, 1993). In other cases, highly accurate cost information fluctuates rapidly, making it difficult for users to understand and operate the information according to their purposes (Iwasawa 2020). In all of these cases, the usefulness of cost information was ensured by giving priority to other characteristics rather than accuracy. In other words, the intrinsic quality (accuracy) of cost information does not directly lead to the satisfaction of cost information by itself, but only when it is combined with other characteristics. For instance, in a situation where the meaning of cost information is difficult to understand and its relevance to the task is weak, no matter how accurate and objective the value, it will not lead to satisfaction. Therefore, we propose the following hypothesis:

Hypothesis 3: Representational and contextual quality moderates the relationship between intrinsic quality and satisfaction with cost information in cost management.

(4) Research Methods

1. Selection of surveyed companies and description of the use of cost information

In order to test our hypotheses, we conducted an in-factory questionnaire survey in six factories of two manufacturing companies that cooperated with our survey (Table 2). Company A is classified as a plastic product manufacturer and mainly manufactures and sells plastic resins. Company B is classified as an electronic equipment manufacturer and mainly manufactures and sells electronic devices, primarily semiconductors.

The surveyed companies were selected for two reasons. First, the companies are implementing improvement activities based on cost information, as are many manufacturers. In these companies, cost information is reviewed at the monthly cost meeting attended by lower managers (equivalent to line managers and section managers) and upper managers in all plants, to confirm the production status of the previous month and to discuss improvements in the following month. Since managers are responsible for the cost of manufactured products and the expenses of their own departments or production lines, they must account to the factory manager for any deviation from the budget target. In addition, each factory's accounting department organizes a series of information on costs as described below in Excel format, and sends it to the managers before the cost meeting.

Second, product cost information is utilized for cost management. Product cost information is sometimes unsuitable for performance management because the responsibility is often ambiguous due to the problem of overhead cost allocation (Obata, 2017). However, in the factory of the target company, the correspondence between manufactured products and production lines is clear; thus, the manufacturing cost of a product group and the responsibility relationship of each manager are clear. Therefore, when the product cost exceeds the budget, the production department is required to improve it. In addition, related departments such as production control and quality control will be included in the discussion to reduce the product cost from the perspective of production planning and product mix. Since intrinsic quality (accuracy and objectivity), which is measured in this study, is often an issue in the calculation of product costs, we

preferred companies using product cost information in cost management for the study.

The following is an explanation of the usage of cost information in the cost management of the companies. The cost information mainly used in the factories of the target company is the product cost information for each product group, the cost information broken down by department and production line, and the material cost information, each of which is shared with the analysis of the difference between the forecast and actual costs. First, with respect to the product cost of each product group, Company A, which manufactures plastic resins, presents the product cost per unit (gram), and Company B, which manufactures semiconductors, presents the product cost per unit. These are calculated within the scope of manufacturing costs and are presented after allocating overhead manufacturing costs. When the actual cost deviates from the budget, each manager is required to explain the cause of the deviation to the factory manager at the monthly cost meeting and to make improvements for the next period. In addition, relevant departments in the factory other than the production department also discuss how to lower costs based on product cost information. For example, the quality control department is required to consider production problems from the perspective of failure costs and losses of specific products, and the production control department is required to examine the production plan and product mix to be manufactured in order to reduce the cost.

In analyzing the factors that cause changes in the cost of products, it is important to have information on expenses and material costs broken down by department and production line. Each department in the factory and each production line in the production department is assigned a budget target for expenses, and the information on actual expenses is compiled and reported monthly. Cost targets are also set for related departments other than the production department in the factory, such as the quality control and safety control departments, and cost information for each department is given. In addition, information on material costs is also important. Since most of Company A's raw materials and Company B's parts are imported, and they are strongly influenced by exchange rates and energy prices, the price of raw materials fluctuates widely. By analyzing the reason for the difference in material costs between the actual and budgeted costs by comparing the material usage rate in each line, the managers are able to make improvements for the next month.

Although the same cost information is reported and used in each factory, it is assumed that the recognition of the quality of the information and the degree of its use vary. As for the intrinsic quality of cost information, Company A, for example, manufactures plastic resins, several basic resin products, and derivative products with special processing according to orders, and the number of these derivative products is several tens of thousands. Therefore, the line in charge of manufacturing basic resin products is a small-mix, high-volume production line, while the line dealing with derivative products is a large-mix, low-volume production line. As a result, even if product cost information is based on the same allocation calculation, the accuracy and objectivity of the information may differ depending on the production line in charge. As for the quality of representation and context, it is presumed that the perception of quality may differ depending

on the users' accounting knowledge, the departments or plants, job titles, the degrees of interest in costs, and relationships with the accounting department.

2. Data collection

The survey subjects were lower managers (equivalent to line managers and section managers) and upper managers who belong to the production department and related departments in the factory. This is because it was expected, based on prior interviews, that they view cost information, make decisions based on cost information, and engage in improvement activities, as already mentioned.

Table 2 Questionnaire survey overview

Company	Factory	Number of subjects	Number of collections	Implementation period
A	P (Japan)	18	17	November 2018
	Q (Asia)	18	14	June–July 2019.
	R (Asia)	16	15	August 2019
	S (Asia)	12	10	September 2019
B	X (Japan)	29	23	February 2019
	Y (Japan)	18	12	
Total		111	91	(82.0%)

In Company A, the questionnaires were distributed by e-mail through the accounting department of each factory, and the respondents then responded directly. In Company B, the survey was distributed and collected via the General Affairs Department. This enabled us to collect the responses without going through the respondents' supervisors, the accounting department, or any other department related to the survey content.

3. Measurement of variables

Cost information quality was measured based on Iwasawa (2020) and Lee et al. (2002) who developed a measurement scale for the four-dimensional model of information quality (Wang and Strong, 1996). Specifically, we modified the expressions of the questions in Lee et al. (2002) to fit the cost information and measured it on a seven-point scale (Table 3). The questionnaire was reviewed in advance by the accounting staff of each factory to ensure that there were no discrepancies in the wording of the questions. The results show that the Cronbach's α of the variables for each quality dimension is generally at a reasonable level[1] (Table 3). In order to avoid multicollinearity, all variables were centered on the mean value.

In addition, as control variables, we set dummy variables for the respondent's company, department (1 for production department), and position (1 for section chief or higher). In each variable, it was considered that the importance of cost information in business operations differs depending on job title; hence, it was necessary to control for the effect[2]. For example, in the case of Company A, which is an equipment industry, and Company B, which is a processing and assembly industry, the

[1] Items assumed as objectivity 2 were excluded because they significantly lowered the Cronbach's α for intrinsic quality

[2] We did not include factories as a control variable because we did not think that they would have a direct impact on the degree of use of cost information or the level of satisfaction, since there were no major differences in production patterns, business contents, or management styles within each company.

Table 3 Measurement of variables

Sub-characteristics	Questionnaire	Min–Max	Avg.	SD
Intrinsic quality (Cronbach'α=0.77)		2–7	4.65	0.91
accuracy 1	The numerical values in the cost information show production conditions extremely accurately.	2–7	4.77	1.10
accuracy 2 (R)	The numerical values in the cost information seem detached from the actual situation.	1–7	4.50	1.36
accuracy 3	The numerical values in the cost information are extremely realistic.	2–7	4.70	1.05
objectivity 1	The calculation process of the numerical values is very transparent.	1–7	4.65	1.22
Representational quality (Cronbach'α=0.91)		2–7	4.71	1.10
conciseness 1	The format is clear and easy to read.	2–7	4.71	1.26
conciseness 2	The cost information is compiled in appropriately sized batches.	2–7	4.66	1.20
understand-ability 1	The cost information was provided in an easily digestible manner.	2–7	4.97	1.25
understand-ability 2	It is easy to locate the occurrence factor and change factor of the costs.	1–7	4.51	1.27
Contextual quality (Cronbach'α=0.84)		2.17–7	4.79	0.95
completeness 1	All necessary data is recorded in the cost information.	2–7	4.65	1.18
completeness 2	The detailed breakdown of the data in the recorded cost information is sufficient.	1–7	4.44	1.22
relevance 1	The recorded information is sufficiently related to my work.	1–7	4.77	1.38
relevance 2	The scope of the cost information is consistent with the scope of my work.	1–7	4.70	1.36
timeliness 1	The reporting of the cost information is perfectly timed for when I need it.	2–7	5.08	1.14
timeliness 2 (R)	The cost information does not reflect the current situation.	1–7	5.13	1.43

(R) indicates the inversion scale.

importance of cost information in business operations is assumed to be different because the proportion of controllable costs for production managers is different due to the difference in the fixed cost ratio.

Table 4 Correlation between quality dimensions

	Intrinsic quality	Representational quality	Contextual quality
Intrinsic quality	1		
Representational quality	0.55	1	
Contextual quality	0.49	0.50	1

(5) Results and Discussion

1. Hierarchical multiple regression analysis

To test the hypotheses, this study conducted a hierarchical multiple regression analysis assuming two models for the two dependent variables: the degree of use of and satisfaction with cost information in cost management. In Model 1, the main effects of intrinsic quality, expressive quality, and contextual quality as well as the control variables already mentioned, were entered. In Model 2, the interaction variables between intrinsic quality and expressive quality and between intrinsic quality and contextual quality were added to the variables in Model 1.

Table 5 shows the results of the multiple regression analysis[3]. Regarding Hypothesis 1, Model 1a confirmed that expressive quality and contextual quality were positively associated with the degree of use of cost information

[3] In terms of multicollinearity, the maximum of Variance Inflation Factor (VIF) for any of the variables in the model was 2.42, showing no major problems with the results of the analysis.

(significance levels of 5% and 0.1%, respectively). As expected, the relationship with intrinsic quality was not confirmed. Therefore, Hypothesis 1 is supported.

Table 5 Results of multiple regression analysis [a]

	Degree of use [b]		Satisfaction [c]	
	Model 1a	Model 2a	Model 1b	Model 2b
Cost information quality dimensions [d]				
Int	-0.07	-0.07	-0.06	-0.05
Rep	0.28*	0.25*	0.33***	0.38***
Con	0.52***	0.53***	0.50***	0.44***
Interactions				
Int * Rep		-0.18		0.25*
Int * Con		0.08		0.01
Control variables				
Company	0.01	0.04	0.07	0.02
Dep	0.10	0.11	-0.01	-0.03
Position	0.07	0.06	-0.09	-0.09
Adj. R^2	0.490	0.496	0.533	0.589
F	15.27***	11.93***	17.90***	16.91***

†p<0.1, *p<0.05, **p<0.01, ***p<0.001

[a] Estimate by least squares method
Coefficients are standardized

[b] **Degree of use**: "I always use the cost information for my assignments in cost management."

[c] **Satisfaction**: "I am extremely satisfied with the cost information reported in cost management."

[d] **Int**: Intrinsic quality; **Rep**: Representational quality; **Con**: Contextual quality

Next, we examine Hypothesis 3. In Model 2b, the effect of the interaction term between intrinsic quality and representational quality on the level of satisfaction with cost information was confirmed at the 5% level of significance. However, the effect of the interaction term between intrinsic quality and contextual quality was not confirmed. Therefore, Hypothesis 3 is partly supported.

Finally, we examine Hypothesis 2. Model 1b confirmed that representational quality and contextual quality were positively related to the level of satisfaction with cost information (5% and 0.1% significance levels, respectively). As for intrinsic quality, although the direct relationship was not confirmed, the effect of the interaction term was significant in Model 2b, as already mentioned, and the indirect relationship was confirmed. Therefore, Hypothesis 2 is supported.

In Model 2a, the main effect is similar to that of Model 1a, and the interaction terms are not significant. These results are consistent with the assumption made when constructing the hypothesis that intrinsic quality does not affect the degree of use of cost information.

These results suggest priority relationships between the characteristics required for cost information (Figure 1). While representational and contextual quality are related to both the degree of use and satisfaction, intrinsic quality is related only to satisfaction and had no effect on the degree of use. This means that no matter how high the accuracy (intrinsic quality), it will not lead to the use of cost information unless the quality of representation and context are ensured. This result is consistent with those of previous studies. These studies reported cases in which other characteristics are often prioritized over accuracy when accuracy is traded off with other characteristics (Hiromoto, 1988; Iwasawa, 2020; Merchant and Shields, 1993). Based on the results of this study, it can be interpreted that representational and contextual quality are prioritized over intrinsic quality because accuracy (intrinsic quality) does not lead to the use of cost information unless other characteristics are improved.

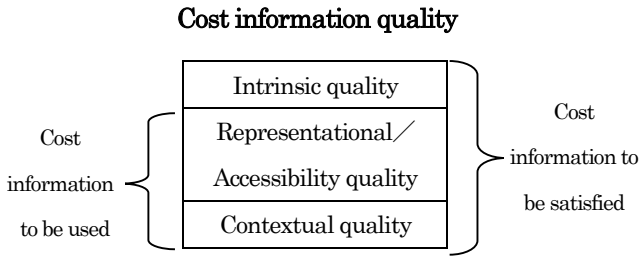

Figure 1 Relationship between cost information quality and degree of use and satisfaction with cost information

2. Simple slope analysis

To test Hypothesis 3 and interpret the results, a simple slope analysis was conducted as an additional analysis because the effect of the interaction term between intrinsic quality and expressive quality was significant. Specifically, referring to Aiken and West (1991), we assumed a single regression line for intrinsic quality when the score of expressive quality was ±1SD (standard deviation), with satisfaction with cost information as the dependent variable.

As a result, when the representational quality was low (-1SD), the relationship between intrinsic quality and satisfaction was not confirmed (β = -0.14, p = 0.34), but when the representational quality was high (+1SD), the relationship between intrinsic quality and satisfaction was suggested (β = 0.24, p = 0.06). This is consistent with the expectation made when constructing the hypothesis that intrinsic quality does not directly lead to satisfaction on its own, but only when high representational quality is used to increase satisfaction.

These results suggest that intrinsic quality is a necessary but not sufficient condition for the satisfaction of cost information. Inherent quality alone, including accuracy, which is the focus of previous studies, is limited in increasing the satisfaction of cost information, and its impact depends on other characteristics. It is true that the discussion on allocation calculation and accuracy is important in cost accounting theory, and the contribution of these research groups is significant. However, the results of this study show that no matter how sophisticated the cost allocation is designed to be and how accurate it is, if other characteristics are not taken into account, the effect will be partial.

(6) Conclusion

The purpose of this study is to clarify the characteristics of cost information utilized in cost management. For this purpose, the framework of cost information quality was applied to enable the comprehensive and systematic measurement of the characteristics required for cost information. The relationship between each characteristic (quality) and the degree of use and satisfaction of cost information in cost management was then clarified by conducting a questionnaire survey in the factory. The results showed that (1) representational and contextual quality is positively associated with the degree of use of cost information, but no relationship is found for intrinsic quality; (2) all quality dimensions are associated with satisfaction with cost information; and (3) the moderation effect of representational quality is confirmed for the relationship between intrinsic quality and satisfaction. These findings indicate the validity of prioritizing expressive and contextual quality over the intrinsic quality dimension in the utilization of cost information, and that intrinsic quality is a necessary but not sufficient condition.

The contributions of this study are as follows. First, by relying on the cost information

quality framework, this study confirmed the relationship between cost information and its utilization with higher explanatory power, where previous studies have not reached a consensus on the results. In contrast to previous studies that focused on a few characteristics, this study used a more systematic framework to show the impact of each characteristic. As a result, this study shows that accuracy alone does not lead to the use and satisfaction of cost information, and that it is important to consider various characteristics.

Second, this study also contributes to the group of studies that have focused on characteristics other than accuracy. Since these studies pointed out the importance of various characteristics, it was difficult to integrate their results. Therefore, by relying on the cost information quality framework, the findings of the previous studies are organized, and several interesting discoveries are made, such as the fact that the impact of each characteristic on the use and satisfaction of cost information is different, and that there is a moderating effect.

Third, the study could accumulate empirical evidence at the individual level of factory managers. In this study, although managers in each factory use the same cost information, their perceptions of the quality of the information differ. This indicates that it is insufficient to investigate cost accounting and information only at the company or factory level, which has been the subject of many previous studies, and that it is important to also investigate it at the lower and individual levels.

However, there are some limitations. First, it is necessary to pay attention to the interpretation of the results because of the measurement problem of cost information quality. In this study, from the standpoint that the perception of cost information quality is important for the utilization of cost information, all the characteristics of cost information are measured by users' perceptions; however, it is assumed that the correctness of the perceptions may vary. It is also assumed that the correctness of cognition may vary. For example, there may be a case where the accuracy of cost information is misperceived as high even though it is actually low due to users' accounting knowledge. In this study, since the dependent variable is also based on users' perceptions such as satisfaction, there is no major problem with the results of the analysis itself, which shows the relationship between the variables. However, as shown in the example, if the actual level and perception are extremely incompatible, it is undeniable that decision making based on cost information may be inappropriate even if the degree of use and satisfaction are high. In other words, it may not be enough to increase the perception of the quality of cost information. Therefore, it would be desirable to conduct research that also considers more objective outcome variables beyond the perception of users, such as organizational performance.

In addition, due to the limited size of the sample, contextual factors could not be considered. Previous studies have shown that the demand for cost information, the effect, and the actual level of cost information differ depending on the contextual factors in the factory.

Despite these limitations, the result of this study that "high quality cost information meeting various characteristics is useful to utilize cost information in cost management" has many academic and practical implications. Based on the findings of this study, further research is desirable.

Acknowledgement

The original version of this paper won the Best Paper Award at the Japan Accounting Association (JAA) and was published in this journal with the recommendation of the president. The author would like to thank the president of JAA, and two anonymous reviewers of Journal of Japanese Management. This paper was supported by JSPS KAKENHI (JP18J22434).

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(Received: December 16, 2020)
(Accepted: March 21, 2021)

Publisher: JFMRA
May 2021