What Shop Floor Management can Contribute to Strategic Cost Management

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Abstract

This paper explores the development and promotion of shop floor management (SFM). It argues that SFM can contribute to strategic cost management by reducing variable costs per unit and lead-time. These reductions are within SFM's discretion, while fixed costs reduction is usually beyond SFM's ability. This study examines Toyota Japan's SFM before 2000 and the reforms focusing only on cost reduction implemented around that time. The reforms have had a serious impact on the Toyota Production System (TPS) and exposed Toyota to a considerable danger of overproduction. As part of these reforms, the SFM's performance is to be evaluated in light of the achievement of full costs, including fixed costs, and no longer only in light of variable costs. Enlightened by the review, this study is engaged in providing an appropriate performance measurement for SFM to integrate cost reduction and lead-time reduction into one indicator, and taking up J-cost theory as an integrated performance measurement. The research is based on a detailed survey of literature and an e-mail interview with Professor Masatomo Tanaka, who once held an important position in Toyota Japan's production management.

Key Word

Toyota production system;

shop floor management;

leadtime reduction;

the reform to management accounting system around 2000 in Toyota;

J-cost theory

1. Introduction

From the standpoint of shop floor management (SFM), there are things that can be achieved and things that cannot in strategic cost management. SFM's potential contributions to strategic cost management should be developed and promoted, and that which is beyond SFM's ability should not be entrusted to SFM, or negative consequences may be inevitable. What the shop floor can manage is variable costs (per unit) reduction and lead-time reduction; full costs reduction including fixed costs is unattainable at the shop floor level.

Cost reduction can be broadly classified into two types: variable costs (per unit)-based cost reduction and full costs-based cost reduction. Only the former is achievable by SFM. The means available to SFM to reduce variable costs (per unit) include improvement of operation processes, reduction in man-hours, elimination of waste, and so on. These are implemented through small-group activities. On the other hand, managing full costs, which are beyond SFM's control, requires the involvement of upper management. Evaluating SFM's performance in light of the achievement of full costs including fixed costs is putting the shop floor in an impossible situation. This may induce the shop floor to give heightened priority to the operation ratio, leading to sub-optimization.

Toyota Japan reformed its management accounting system around 2000 and began to evaluate SFM's performance in light of the achievement of full costs including fixed costs. As a consequence of these reforms, Toyota has been exposed to a considerable danger of overproduction, which is regarded as the worst type of waste at Toyota. Why was it necessary for Toyota to implement such reforms? This study investigates the issue.

Regarding lead-time reduction, it is difficult to convert the effects of physical practices to the accounting effects directly, and consequently it has not been justified in traditional accounting. Without knowing the exact relationship between lead-time reduction and company performance, Taiichi Ohno (1978) thought that lead-time reduction would improve the business constitution. So he asked the shop floor to implement cost reduction based on

variable costs and lead-time reduction simultaneously. According to Ohno, on a basis of quality secured from automation (in Japanese “Jidoka”), improvements can be made locally to reduce costs and lead-time, and increased profits will follow later. However, this essential principle of the Toyota way grew out of various experiences, and it is difficult to quantify from the perspective of accounting. The improvement effects of lead-time reduction are not appreciated systematically, and it is unfavorable as a practical means of SFM. Therefore, SFM is liable to put more stress on cost reduction, which is easier to account for. But what, precisely, will be changed and improved if lead-time is reduced? A performance measurement for lead-time reduction must be developed for common use at the local level.

It is said that quality, cost, and lead-time are the most important factors at the local level. As mentioned above, quality should be regarded as the basis of cost and lead-time improvement. However, in what manner should both be dealt? Should cost reduction and lead-time reduction be encouraged separately or concurrently? How, precisely, might both be engaged concurrently? This paper will describe a measurement that could be adopted for evaluating SFM’s performance.

In Japan and foreign countries, the research on target costing advanced rapidly after the 1990s. Actually, to reduce the costs, Kaizen costing is as important as target costing. It has been pointed out that except for Monden (1995), research on Kaizen costing is insufficient compared with target costing (Sakurai, 1997), and research on Kaizen costing has not increased, even after 2000. This study attempts to fill this gap in research on SFM.

This paper is based on a detailed survey of literature and an e-mail interview conducted with Professor Masatomo Tanaka, [2] who previously held an important position in Toyota Japan’s production management. This interview was conducted by the author on 24 August, 2010.

The rest of this paper is organized as follows. In the next section, it reviews Toyota Japan’s SFM system before 2000. Then, it examines Toyota Japan’s reforms to its

management accounting system, which were implemented around 2000. After that, it discusses ways to encourage SFM to take up J-cost theory. It summarizes the findings and implications of this study in the final section.

2. Toyota's Shop Floor Management System before 2000

Toyota Production System (TPS) is a method of thoroughly eliminating waste and enhancing productivity. In TPS, waste refers to all elements of production that increase cost without adding value (Ohno, 1988a). All waste eventually becomes part of the direct and indirect labor costs, depreciation costs, and general management expenses. They make the costs increase. "Considering these facts, we can never ignore cost-raising elements. The waste caused by a single mistake may eat up the profit that ordinarily amounts to only a few percent of sales and thereby endanger the business itself" (Ohno, 1988a, p. 55). These cost facts lie at the heart of TPS, which aims to reduce costs.

Previously, Toyota's SFM aimed at reducing cost by reducing both variable costs per unit and lead-time. Usually, cost reduction is preferred to lead-time reduction at the local level. The former's improvement effects are linked to accounting numbers relatively, and it is easy to evaluate performance. In the latter case, since its physical improvement effects are difficult to assess using traditional accounting methods, lead-time reduction is not evaluated appropriately, and so it tends to be slighted. However, Ohno (1978), who suggested the importance of lead-time reduction, insisted on cost reduction based on both variable costs per unit and lead-time reduction simultaneously.

2. 1 *Variable Costs-based Shop Floor Management*

Toyota executed the manufacturing division's budgeting in 1956. According to Toyota (1987, p. 305), "Masaya Hanai as chief accounting officer has tried to raise cost consciousness by holding a divisional expense conference with each division monthly. As cost information is

provided to the shop floor, the motivation for cost reduction in each division has risen," and also the costing office of the accounting division provided the shop floor with cost reports based on standard costing. (Japanese Humanities Association, 1963) In other words, the accounting division considered the effects of full costing positively and tried to encourage the shop floor to practice cost reduction by using full costs information.

On account of the above, Toyota used to display full costs information on the shop floor to encourage cost reduction. The full costs information may be regarded as providing visibility to the shop floor. However, afterwards Ohno rejected full costs and claimed, "I dislike full costing…. When there was time to think about the full costing, go out to the site and do the improvement" (Kawada, 2004, p. 58).

Ohno mentioned that he thought about full costing and penetrated TPS to the local level. He stated, "It's hard from the local standpoint to take the illusion that it is more efficient and probably cheaper to process items in batches than one at a time. Where costs are involved, 'number-pushers' rush in and talk about costs in a way that creates the illusion that once a press setup is completed, it is cheaper to run 10,000 rather than 1,000 pieces. This illusion, backed up by calculations, is always acknowledged as truth" (Ohno, 1982, p. 25; Ohno, 1988b, p. 18) Ohno was conflicted about the actions prescribed by traditional accounting principles. However, he did not have evidence to prove that he was right, and the only way to implement his idea was by force. He said, "The only way I was able to implement it (TPS) was by using a gun. I forced people to do it my way, because I did not understand why it should be done that way. No one had ever developed a theory…. I not only kept the cost accountants out of my plants; I tried to keep the knowledge of cost accounting principles out of the minds of my people" (Fox, 1986, p. 20).

How should Ohno's instincts and view of cost be interpreted? Ohno decried cost accounting principles and cost accountants, and drove them out of Toyota's local level concern. Normally cost accountants not only allocate fixed costs, but also calculate variable

costs. Therefore, it appears that fixed costs and variable costs were out, and there was no longer accounting information in Toyota's shop floor. Toyota's shop floor then engaged in continuous improvement using physical information alone. It was as if accounting information were evil and physical information were good, and the essence of Toyota's SFM came to be associated with physical numbers instead of accounting numbers.

In *Relevance Regained* (Johnson, 1992) and *Profit beyond Measure* (Johnson & Bröms, 2000), the importance of Management by Means (MBM) derived partly from SFM of Toyota Motor Manufacturing – Kentucky (TMM-K) is emphasized, and Management by Results (MBR) is criticized. It is argued that the accounting information should be completely excluded from local concern, and SFM should be engaged in MBM. In these works, the accounting information comprising fixed costs and variable costs is regarded as the result, and there should not be any accounting information in the process management. Therefore, in MBM, the means refer only to physical control. Johnson and Bröms recognize Toyota's SFM structure as accounting control versus physical control. Specifically, the accounting division manages with accounting information, and SFM manages with physical information. On this point, if Johnson and Bröms have misinterpreted Toyota's SFM, or if the management practices are different between Toyota Japan and Toyota America, further studies will be designed.

Here, it is necessary to clarify what Ohno has driven out of Toyota's SFM, to clear up the confusion. Ohno said, "I dislike full costing," but on the other hand he was certainly cost conscious and thought about cost reduction all the time (Ohno, 1988a; Ohno, 1988b). Actually, what Ohno has driven out at Toyota were full costing principles and fixed costs. What troubled Ohno was fixed costs allocation in full costing, and variable costs are used in Kaizen costing at the local level.

According to Ohno (1988b, p. 40), "it all boils down to how we use our heads, leaving us innumerable ways to lower overall costs. Low-volume production ends up running into really

big money when you have people solemnly citing individual costs and going on about what is profitable and what is not. All too often somebody tells you that you have to give up on your most profitable car because (the) numbers show you are in the red. So you abandon the model that has really been making you the most money and break your back trying to sell lots of unprofitable cars as though they were making you rich." From such a statement, it is clear that Ohno was suspicious of the allocation method of full costing. What troubled him was the sole problem related to fixed costs allocation.

Moreover, the target reduction amounts are set for variable costs under Toyota's Kaizen costing (Monden, 1995). There are two sides to the implementation of Kaizen costing: the accounting control system and the physical control system. The target reduction amounts are calculated by applying a deductive method to the companywide profit plan that has been decided by top management. This is the accounting control system of Kaizen costing. However, the responsibility for achieving these targets is placed entirely on the shop floor. This is the physical control system of Kaizen costing. Hiromoto (1986, p. 76) notes, "taking the market forces into account, the target reduction amounts are determined by the target profit, then they are used to control the movement on the shop floor." The actual results of cost improvement are measured using accounting numbers in the Kaizen costing office, and accordingly the flow from the accounting control system to the physical control system is established to make sure that SFM is aligned with the company's profit. The cost reduction amounts assigned to the manufacturing division will be achieved by reducing variable costs such as direct materials costs, direct labor costs, and variable indirect costs.

When Professor Tanaka worked at the shop floor in Toyota from 1967 to 1994, he was involved in cost reduction based on variable costs, such as direct costs and utility expenses (electricity + water + steam), and direct costs are shown as follows. [3]

Direct costs=direct labor costs (labor-hours*allocation rate)

+materials costs (materials that become a part of vehicle to be shipped)

+supplemental materials costs (cutting fluid, materials not to be shipped)

+tool costs (drill, welding tips, etc.)

+consumable costs and light work costs (mold wash, mold repair, etc.)

As we have seen above, Ohno was only concerned about fixed costs allocation in full costing, and he insisted that fixed costs should be driven out of SFM. The full costs including fixed costs were anathema to Ohno and were kept out of SFM's hair. However, Ohno never suggested excluding variable costs from local concern. Thus, in Toyota's SFM, the problem can be regarded as variable costs versus full costs. The accounting information on variable costs per unit and the related accounting targets are utilized as important performance measurements in Toyota's SFM.

2. 2 *Lead-time Based Shop Floor Management*

SFM can make efforts not only to reduce the above-mentioned variable costs per unit, but also to reduce lead-time. When Ohno was asked, "What is Toyota doing now?" he answered, "all we are doing is looking at the time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value-added wastes" (Ohno, 1988a, p. i).

The time from receiving the purchase order to collecting the cash is regarded as lead-time for the whole company. And SFM-related lead-time (production lead-time) is from when a customer's order is taken until the product is shipped. After taking the order, the goods must be produced and delivered within the allowable time. If this cannot be achieved, some inventory has to be stored. However, if the goods can be produced and delivered within the allowable time through continuous improvement, there is no need for extra inventory. Just in Time (JIT) production is a way to produce exactly what it is needed in the necessary

quantities within the allowed time. To implement JIT production, the Kanban system was adopted. All the production-related processes are totally synchronized corresponding to customers' needs. Through lead-time management, Toyota "has always suppressed overproduction, producing in response to the needs of the marketplace" (Ohno, 1988a, p. 108).

Toyota manages lead-time by tact time, which is the time allocated to make one piece or unit. Tact time is the operable time divided by the daily customer demand quantity. Operable time is the length of time that production can be carried out per day. In short, it is the available daily production time (Ohno, 1988a). Customer demand quantity per day is the quantity required per month divided by that month's number of operating days (Ohno, 1988a). When tact time is determined, lead-time will be determined too (tact time*process number=lead-time). By reducing the lot waiting time and process waiting time, lead-time will be improved.

Setup time reduction is an example of an improvement activity executed by the shop floor. Setup is regarded as an element that reduces efficiency and increases cost (Ohno, 1988a). By producing small lot sizes and executing quick setup to generate a continuous workflow and reduce lead-time, the needs of the subsequent process or the end customer will be satisfied in a timely manner. In the 1940s, Toyota's changeover took two to three hours, longer than the manufacturing time on a lot of shop floors. Ohno made efforts such as pushing "production leveling" to reduce setup time to under an hour and sometimes succeeded in reducing it to 15 minutes. Finally, in the 1960s, it was down to a mere 3 minutes (Ohno, 1988a).

Ohno was concerned about how to evaluate the effects of lead-time reduction from the perspective of accounting. Regarding the saved time, Ohno stated, "suppose a retooling setup that used to last one hour now only takes 10 minutes. When dealing with a small number of items, you can process them all in the time you have saved. If it now only takes 10 minutes to do a setup that used to require one hour, you could retool for the low-volume Part

A in 10 minutes and process scores of pieces in 10 minutes. In another 10 minutes you could retool for Part B and then do 10 minutes of processing. When you are 10 minutes away from the one-hour mark, you could get going with the large-lot Part C. This means that, in the time you save, you can process 50 or so of each kind of small-lot item. It seems as though we have gotten something for free in this example. The accountants may not accept the idea of something for nothing, but the fact is that cooperation has made it possible to do in 10 minutes what used to take an hour. How do we link that saving to lowered costs? With those 50 minutes, rather than figuring that it would be cheaper to process Part A in greater quantities, we can complete, say, 50 additional units per month" (Ohno, 1988b, p. 40).

In the above statement, it is clear that Ohno suggested evaluating the effects of lead-time reduction from the viewpoint of increased revenue, but he expressly intended to "link that saving to lowered costs" (Ohno, 1988b, p. 40). Maybe it is because he is too particular about costs. Ohno explained the effects of lead-time reduction by using the savings to produce other products. That is, by using the savings to produce other products, the revenue under a certain period will increase, and that will contribute to profits. Therefore, although the term "cost" is frequently used, reduced lead-time actually results not in cost reduction but in revenue growth. It is not clear so far exactly how lead-time reduction would bring an economic advantage. The above remark from Ohno explained that lead-time reduction would contribute to profits by increasing revenue.

Hereinbefore, Toyota's SFM was described as being engaged into variable costs (per unit)-based cost reduction and lead-time reduction simultaneously. Both cost reduction and lead-time reduction were conscious of accounting effects.

Ohno cited manpower reduction as one means available to SFM: "In the Toyota production system, we think of economy in terms of manpower reduction and cost reduction. The relationship between these two elements is clearer if we consider a manpower reduction policy as a means of realizing cost reduction, the most critical condition for a business's

survival and growth. Manpower reduction at Toyota is a company-wide activity whose purpose is cost reduction. Therefore, all considerations and improvement ideas, when boiled down, must be tied to cost reduction. Saying this in reverse, the criterion of all decisions is whether cost reduction can be achieved" (Ohno, 1988a, p. 53). Ohno valued process management; however, he never ignored the results derived from the process.

Another example is that improving efficiency is not necessarily the same thing as reducing costs. On a production line, ten workers produce perhaps 100 pieces of product per day. Improvements are introduced to increase efficiency, and then the same ten workers could produce perhaps 120 pieces per day, a 20 percent increase in efficiency. If demand were to rise at this point, production could be increased to 120 pieces a day without having to increase manpower. Obviously, this cost reduction would increase profits. Now, suppose that market demand drops to 100 or 90 pieces per day. If we continue to make 120 pieces a day because of our improved efficiency, we will have 20 to 30 pieces left over daily. This will increase our material and labor expenses and result in a serious inventory problem. In this case efficiency improvement cannot be called cost reduction. If only 100 pieces are needed, eight workers should be used to improve efficiency while reducing costs. If 90 pieces are needed, seven workers should be used, and so on. All of these instances require that the process be improved (Ohno, 1988a).

3. The Reform to Management Accounting System around 2000 in Toyota

3. 1 *The Background of the Management Accounting System Reform Around 2000*

When the person in charge changes, then the company changes. In times when strong leaders existed to promote Toyota's SFM, cost reduction and lead-time reduction were applied simultaneously. However, after the leaders retired, their SFM's balance collapsed. Toyota's SFM was split into two groups: one was the "cost reduction group," which insisted on cost reduction based on variable costs per unit, and the other was the "lead-time reduction

group," which insisted on lead-time reduction. The controversy has continued between the two groups ever since. [4]

According to Shinohara (1996, p. 28), "due to Japan's rapid economic growth in the 1950s and large-scale boom in the 1960s, Toyota has strengthened its financial constitution by its high profitability. Due to the expansion of its internal funds, it was called 'Toyota bank.' Accordingly, the accounting and financial divisions slid to have more influence than the manufacturing divisions." As the influence of accounting and financial divisions strengthened gradually, Ohno retired as vice president in 1978, and Kikuo Suzumura, the chief examiner of production and research division, retired in 1982. The leaders who had introduced and established TPS left Toyota one after another, and there were no strong leaders to replace them in implementing TPS. It has been pointed out that TPS has since been transformed (Kaneda, 1991; Nomura, 1993; Shinohara, 1996; Satake, 1998).

Professor Tanaka described the controversy between the "cost reduction group" and the "lead-time reduction group" following the retirement of strong leaders like Ohno and Suzumura: "In about 1980–1999, a controversy was engaged between the 'cost reduction group' and the 'lead-time reduction group.' However, then people noticed that the 'lead-time reduction group' was out of favor at Toyota, and the 'cost reduction group' remained. Around 2000, the 'lead-time reduction group' was not even present on Toyota's shop floors anymore." [5] It is clear from the e-mail interview with Professor Tanaka that at the end of the long-running controversy between the two groups, the "cost reduction group" seized the initiative around 2000 and the "lead-time reduction group" was out of favor at Toyota. The "cost reduction group" reformed the management accounting system, focusing only on cost reduction.

Why did the "cost reduction group" reform the management accounting system? Various released materials show the reasons for the increased cost consciousness of the shop floor and support decision-making of internal or external production due to the intensification of

cost competition in global markets (Wang, 2010). Furthermore, SFMs had devoted their energies to doing the utmost since the 1950s, and there was not much room for cost reduction based on variable costs.[6] Repeatedly setting target reduction amounts based on variable costs in every period eventually had the effect of squeezing out a dust-cloth one more time—eventually there was simply not much more that could be done. One drawback of variable costs (per unit)-based cost reduction is that the shop floor can suffer from burnout, and this may hinder motivation. So, it seems that in such a situation, in order to promote SFM, the "cost reduction group" determined to evaluate SFM's performance in light of the achievement of full costs, including fixed costs.

3. 2 *Fixed Costs-based Shop Floor Management*

As fixed assets are necessarily prepared in advance for the management capabilities, fixed costs are subject to budgetary control. They are the costs determined by the decisions of upper management, and usually the shop floor is unable to reduce fixed costs through the activities and tasks it performs. For fixed costs management, the total budgeted amount of each cost element is considered a target. If the actual performance is better than the budgeted amount, the rationalization objective is regarded as achieved (Monden, 2000). SFM is not given the authority over fixed assets investments and receives fixed costs as they have already been determined. There is little room for fixed costs reduction at the production stage.

It is not as if there were no way to reduce fixed costs as a result of SFM's efforts. SFM can be engaged in facility improvement and maintenance at the local level, such as Total Productive Maintenance (TPM).[7] Also, more generally, SFM could investigate the utility ratio of capacity at its root. For example, fixed asset equipment could be monitored through the operating ratio. SFM could raise the operating ratio through rationalizing the production processes and improving efficiency, and in turn increase production numbers. That is, fixed

costs per unit can be reduced indirectly through increased production numbers.

However, the “Matching Concept” in the accounting system might be abused. To reduce fixed costs per unit, the shop floor might increase the production volume in order to over-absorb the fixed costs intentionally. A decrease in the cost of goods sold would be evident because of the lowered fixed costs per unit. However, inventory increases as a consequence. When the maximization of production is rashly pursued, the financial statements might look good temporarily, but in the long term overproduction absolutely harms the business constitution.

In Ohno’s day, the accounting information on fixed costs was desperately driven from Toyota’s shop floor. Is it feasible to bring it back? Usually, when the accounting information on fixed costs is given, the shop floor might yield to the temptation to increase production. Toyota might think that its shop floor has become immune to accounting information on fixed costs and will not be puzzled, since it has exercised the plant-first principle for decades.

As part of the reforms to the management accounting system implemented around 2000, a “Plant Total Cost Management” [8] (PTCM) system was introduced to Toyota’s shop floor. Regarding the background behind the introduction of these reforms, Professor Tanaka stated, “the issue of unfairness arose, while manpower reduction did not distinguish whether it was accompanied by equipment investments or not. So a movement to correct the unfairness started. The equipment investments were taken into consideration, and the plant costs that included variable costs until 1990 were expanded to include full costs including fixed costs.” [9] Through the introduction of the PTCM system, Professor Tanaka claims that, “the compensation for production interruption time when the ‘Kanban’ didn’t come as planned was withdrawn. So if the shop floor does not produce, it will show in the red. Toyota has become a ‘normal’ company.” [10] Moreover, under the PTCM system, Hiki (2005, p. 119) notes that, “the authority to make decisions regarding fixed assets investments is still under

the production engineering department," but "the plant has the responsibility of reducing total costs including not only variable costs but also fixed costs, and the achievement of full costs are to be evaluated." That is, SFM's performance is to be evaluated in light of the achievement of full costs including fixed costs, no longer only in light of variable costs reduction. Thus, to reduce full costs including fixed costs per unit, SFM is liable to attempt to increase production volume. To determine whether or not Toyota is completely immune to accounting information on fixed costs, and how long it can remain so, further research needs to be conducted.

In this section, the reforms to the management accounting system implemented around 2000, which were led by the "cost reduction group" focusing only on cost reduction, was studied. There is little room for cost reduction based on variable costs per unit, but there is still much room for lead-time reduction. There might be significant differences depending on the field of industry, according to Kawada (2005, p. 38), who wrote that, "regarding the ratio of non-processing time and processing time that comprise lead-time, supposing from the rule of thumb and financial reporting, 90% is non-processing time and only 10% is processing time. Even in the advanced automobile industry such as Toyota, Nissan, and Honda, 50% is non-processing time. In a word, the stagnation time is 50%."

However, the problem for the shop floor engaged in lead-time reduction is that the improvement effects are difficult to assess using traditional accounting methods, at either the shop floor level or the firm level. Without an accurate performance measurement for lead-time reduction in accounting, SFM is liable to slight lead-time reduction in practice. A solution to this problem is examined below.

4. A Performance Measurement for SFM

Lead-time reduction is as important as cost reduction based on variable costs per unit, but how could both be engaged simultaneously?

Previously, the reduction amounts were measured only by multiplying the usage and the unit price together; lead-time was not taken into account. Cost reduction and lead-time reduction were determined by separate measurements, and there was no integrated measurement that brought them together. Is it possible to bring cost reduction and lead-time reduction together into one integrated measurement? From SFM's standpoint, it is more operation-effective to have a simple performance measurement, and one integrated performance measurement is better than two separate ones. So SFM has more room to exercise its discretion, and that will raise the shop floor's motivation. Of course, since this integrated indicator mixes cost and lead-time, it is difficult to transform it into a concrete figure for accounting purposes strictly. However, it is important for SFM to be able to value the improvement effects of cost reduction and lead-time reduction simultaneously.

Regarding such an integrated performance measurement, there is J-cost advocated by Professor Tanaka. J-cost balances cost reduction together with lead-time reduction, and it could serve as the shop floor's performance measurement if the shop floor is asked to reduce both costs and lead-time.

4. 1 ***The Making of J-cost Theory***

In general, steady improvements could be achieved in the first one to two years after implementing TPS, and the shop floor could be changed dramatically. Effects would include:

1) The shop floor becomes more spacious;
2) Equipment trouble and product defects decrease;
3) Excessive manpower clearly emerges, and that makes it possible to support other factories' production;
4) Extra inventory decreases and lead-time shortens.

However, the Key Performance Indicator (KPI) imposed on SFM only considers cost reduction, so even when various improvements such as lead-time reduction are achieved,

only material savings from defective products and labor costs savings would be evaluated. In addition, target reduction amounts are assigned repetitively. As a result, cost reduction would go smoothly for the first one to two years, but in the third year there would be little room for cost reduction, and the shop floor would suffer setbacks. On the other hand, although the improvements of reducing inventory and shortening lead-time are needed, practicing these kinds of improvements will not be evaluated (Tanaka, 2008).

Professor Tanaka states that, “there are few concrete performance measurements for the operating managers who are engaged in improvement activities, as how they should command the shop floor, what they should regard as a problem, how they should evaluate the improvement” (Tanaka, 2004, p. 85). In response, Professor Tanaka contemplated a new performance measurement, with an eye toward ease of use on the shop floor and an accurate approximation of reality. In 2004, he came up with and advocated J-cost theory, [11] which referred to the general theory comprising J-cost.

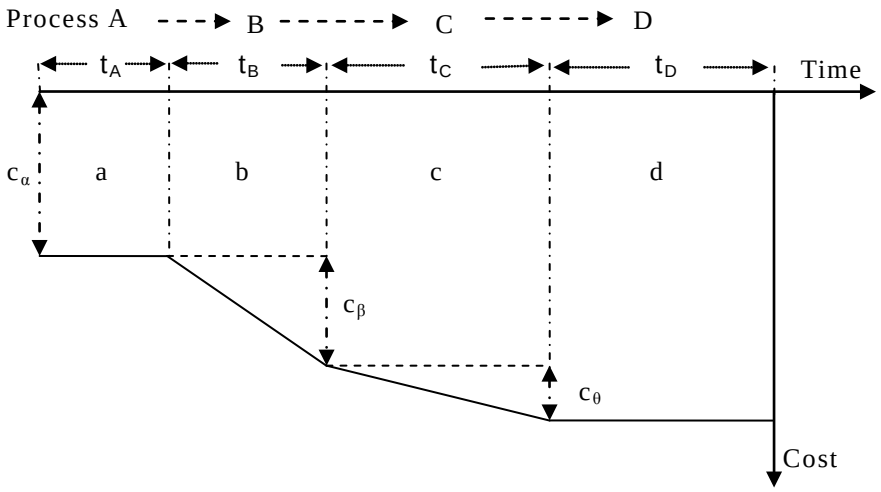
J-cost means the area (shown in J-cost figure) that multiplies costs by a time factor [12] in which a time value consistent with JIT philosophy is taken into account. In J-cost theory, the methodology of cost*time, which had never been used in traditional accounting, is adopted and defined. The unit of costs could be any currency, and it is best if the unit of time is a single day, in order to more precisely consider daily improvement activities. The costs in J-cost indicator refer to variable costs, such as materials costs, coating costs, and direct labor costs, which are at SFM’s discretion. As other costs, such as depreciation costs, indirect labor costs, and indirect operating costs exceed shop floor’s ability, they are not considered by the J-cost indicator (Tanaka, 2004). Two factors are engaged to reduce J-cost: (1) lead-time, and (2) variable costs.

4. 2 *J-cost as a Local Performance Measurement*

Following the plant-first principle to trace the flow of one unit of the product (i.e., how and

where the operations were handled, how much costs and time were spent on it), a J-cost figure that schematizes the way of J-cost could be drawn. In a J-cost figure, the horizontal axis shows lead-time, while the vertical axis shows cost. The parts flow through processes A, B, C, and D in the plant; c_α, c_β, c_θ represent the inputted costs for each process, and t_A, t_B, t_C, t_D represent the lead-time spent for each process. J-cost for each process is the area indicated by a, b, c, d.

J-cost Figure



The total J-cost [13]=a + b + c + d

$$= (c_\alpha)* t_A+ (c_\alpha+ c_\beta/2)* t_B + (c_\alpha+ c_\beta+ c_\theta/2)*t_C + (c_\alpha+ c_\beta+ c_\theta)*t_D$$

Thus, the total area shows the total J-cost of one unit, and it visualizes the large J-cost in a J-cost figure. Regardless of whether one is considering processing time or non-processing time, shortening lead-time would directly shrink the area of J-cost, and it is better to be primarily engaged in the larger areas.

The total J-cost equates with the inventory that is used to make one unit of the product, and in J-cost theory this inventory is called J-inventory. Accordingly, in order to distinguish J-cost theory from traditional accounting, usually the definition in J-cost theory is marked with a “J,” for example, J-profitability. The profitability in J-cost theory is regarded as follows:

J-profitability=Gross operating profit/the total J-cost

=Gross operating profit/J-inventory

Under J-cost theory, the aim is not to reduce costs or lead-time alone, but to reduce the total J-cost. The effects of reducing costs such as c_α, c_β, c_θ are captured together with the effects of shortening lead-time, represented by t_A, t_B, t_C, t_D. Since J-cost appreciates improvements at the shop floor level, it is useful for decision making in SFM. The following two examples examine the applications of J-cost theory [14].

Firstly, here is an example of the necessity of transferring manufacturing to a country where the processing costs are lower. A certain product costs 200 Euros in raw materials. It costs 45 Euros and takes six days if processed in Germany. It costs five Euros and takes seven days if processed in Vietnam. Additionally, it takes one Euro and five days to ship the materials to Vietnam, and another two Euros and five days to get it back. The selling price in Germany is 350 Euros. The question is, which solution is more profitable?

Traditional accounting suggests that profitability should be assessed by subtracting the manufacturing costs from the selling price. It shows that the gross operating profit is higher by 35 points {(142-105)/105} when production occurs in Vietnam.

Gross operating profit $_{\text{Processing in Vietnam}}$: 350-(200+1+5+2) =142 Euros

Gross operating profit $_{\text{Processing in German}}$: 350-(200+45) =105 Euros

However, using J-cost theory, which accounts for not only costs but also lead-time, a different solution appears.

J-cost $_{\text{Processing in Vietnam}}$: (200+1/2)*5+ (200+1+5/2)*7+ (200+1+5+2/2)*5=3,462 Euros*day

J-cost $_{\text{Processing in Germany}}$: (200＋45/2)*6=1,335 Euros*day

Accordingly, J-profitability under J-cost theory is as follows:

J-profitability $_{\text{Processing in Vietnam}}$: 142 Euros /3,462 Euros*day=0.0410/day

J-profitability $_{\text{Processing in Germany}}$: 105 Euro/1,335 Euros*day=0.0787/day

Using J-cost to calculate costs together with lead-time factor, it is found that

J-profitability is higher by 92 points {(0.0787-0.0410)/0.0410} when production occurs in Germany. Conventionally, many manufacturers that pay attention only to low processing costs and transfer production to low-costs countries may suffer a deterioration of profitability. It is dangerous not to examine costs thoughtfully in advance of making a decision to transfer production.

The second example is about one complex problem that has long puzzled operating managers: How much will be lost if a company carries a 1,000 Euro stock one day longer? Asking accountants this question, they refer to the bank lending rate and answer, “capital costs are cheap, as little as 5% annually, so it will lose only 0.14 Euro daily (1,000 Euros * 5% / 365 days).” But is this really correct?

In J-cost theory, if a 15,000 Euro inventory generates a 60,000 Euro gross operating profit annually, then J-profitability is 4.0/year.

4.0/year=60,000 Euros/ (15,000 Euros*one year）

In addition, if there are 240 operable days in one year, then J-profitability is 0.01667/day.

0.01667/ day=4.0/240 days

Thus, a 1,000 Euro stock would cost 16.7 Euros daily.

16.67 Euros/day=1,000 Euros*0.01667/day

Using capital costs to evaluate inventory-carrying costs will underestimate the disadvantage and is likely to increase inventory. However, J-cost theory clarifies that holding a 1,000 Euro stock one day longer will cost 16.67 Euros.

5. Discussion and Conclusion

This study has focused on SFM, specifically regarding how to deal with cost reduction based on variable costs per unit together with lead-time reduction on the shop floor and suggesting a method to evaluate the improvement effects.

The costs that can be reduced at the shop floor’s discretion are variable costs per unit,

while fixed costs reduction exceeds the shop floor's ability. Previously, Toyota had balanced cost reduction based on variable costs per unit together with lead-time reduction under Ohno's leadership. However, when the strong leaders who had introduced and established TPS retired, a controversy between the "cost reduction group" and the "lead-time reduction group" developed. Then, around 2000, at a time when the "lead-time reduction group" was out of favor at Toyota, the "cost reduction group" gained the initiative and reformed its management accounting system focusing only on cost reduction. Since there was little room for cost reduction based on variable costs per unit, the "cost reduction group" shifted evaluation of SFM's performance to include full costs including fixed costs. This was intended to raise the shop floor's motivation.

Regarding how to deal with cost reduction together with lead-time reduction, this paper suggests that integrating both into one measurement is more operation-effective for the shop floor than using the separate ones. Related to this suggestion, J-cost theory has been featured. J-cost theory visualizes cost reduction and lead-time reduction simultaneously. It weighs cost reduction and lead-time reduction on a balance, and would be a useful performance measurement for SFM.

Cost reduction and lead-time reduction contribute to profits, but the ways they contribute to profits are different. Cost reduction relates to profit primarily by lowering variable costs per unit, then by decreasing the cost of goods sold. On the other hand, lead-time reduction makes it possible to produce more other products by generating excess capacity in the same time-frame, subsequently increasing the revenue and contributing to profits. Therefore, lead-time reduction relates to profits from the earnings side rather than from the cost side. Moreover, lead-time reduction will improve the cash flow. Lead-time reduction as one means of strategic cost management is earnings-oriented and should be distinguished from cost reduction. Integrating cost reduction and lead-time reduction into one performance measurement is likely to capture profits from both the cost side and the earnings side.

Previously, inventory control was evaluated from the perspective of capital. Thus, carrying inventory meant that capital was restrained and capital costs were counted. In time, inventory control came to be evaluated from the perspective of interest, and the disadvantage of carrying inventory was underestimated. Indeed, reducing inventory meant to improve the cash flow and produce things that sell well. This will increase the earnings and consequently contribute to profits. It is difficult to tie inventory reduction to profits, unless the story of extra capacity is considered.

Lead-time reduction contributes to profits primarily by improving capacity and then by producing more products, subsequently increasing revenue. However, although lead-time reduction makes it possible to produce more products by generating excess capacity in the same time-frame, it would not contribute to profits if there is not much to produce. Therefore, there is an assumption that the other products made through utilizing the generated capacity could be sold. These products could be sold because a dominant competitive advantage has been created as a result of the shortened lead-time. That is, the shortened lead-time has the effect of improving customer satisfaction, and that makes the products sell better. Thus, lead-time reduction could lead not only to the production of more other products by generating excess capacity, but it could also lead to better sales by improving customer satisfaction. Here, lead-time reduction has a double action. The interaction between the generated capacity and improved customer satisfaction jointly contributes to profits. The importance of lead-time reduction as one means of strategic cost management is understood in a new light.

Finally, this paper concludes with a future research topic. This paper has considered why the “cost reduction group” reformed Toyota’s management accounting system around 2000. However it did not develop an argument about the impacts of the reforms. As is well known, “Toyota Shock [15]” occurred in 2008. The reforms of 2000 might be related to this event. These reforms led Toyota’s SFM to be evaluated in light of the achievement of full costs

including fixed costs. And because of that, the shop floor had to pursue production volume in order to reduce fixed costs per unit. This situation consequently led to an increase in inventory, and Toyota could not respond to the financial crisis stemming from USA in 2008. It is supposed that the reforms were a remote cause of “Toyota Shock,” and this will be clarified with subsequent research.

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Notes

[1] In this paper, strategic cost management is referred to as a concept including profit management.

[2] Professor Tanaka joined Toyota Japan in 1967 and moved to Takaoka factory (Japan) in the same year. He served at the Tahara factory (Japan), where he directed TPS implementation to the whole process of the factory in 1980. Then he became the manager of production and research division at the headquarters in 1993, and consulted regarding TPS implementation with cooperating firms. In 1995, he was in charge of the logistics division at the headquarters. He was transferred to the Institute of Technologists located in Saitama Prefecture, Japan in 2001. He was the first professor to leave Toyota to teach TPS. Currently, he is emeritus professor at the Institute of Technologists, and specially-appointed research associate at the Graduate School of Economics of Tokyo University. He also makes efforts to help firms improve SFM and implement J-cost, which will be mentioned later.

[3] Through the e-mail interview with Professor Tanaka conducted by the author on 24 August, 2010.

[4] Through the e-mail interview with Professor Tanaka conducted by the author on 24 August, 2010.

[5] Through the e-mail interview with Professor Tanaka conducted by the author on 24 August, 2010.

[6] According to the e-mail interview with Professor Tanaka conducted by the author on 24 August, 2010, "Toyota's shop-floor has practiced cost reduction strictly by using variable costs since the 1950s when it was on the verge of bankruptcy. And the norm of cost reduction as several percent every six months has since been imposed. In the 1990s the shop-floor that has done cost reduction for 40 years said jokingly, 'it is not strange, even the costs become zero.' Especially, since the assembly operations were hand-work, it became harder and harder. As a result, the employees' retention rate decreased, and the production was obstructed due to worker shortages. In addition, there was concern about the impact on the quality."

[7] According to the Japan Institute of Plant Maintenance, "TPM aims at maximizing equipment effectiveness with a total system of preventive maintenance covering the entire life of the equipment. Involving everyone in all departments and at all levels, it motivates people for plant maintenance through small-group and voluntary activities."

[8] Through the e-mail interview with Professor Tanaka conducted by the author on 24 August, 2010.

[9] Through the e-mail interview with Professor Tanaka conducted by the author on 24 August, 2010.

[10] Through the e-mail interview with Professor Tanaka conducted by the author on 24 August, 2010. Also in the same e-mail interview, Professor Tanaka stated, "for example, when the scheduled production plan is 500 pieces in one day (X hours), due to the breakdown of equipment under the SFM's responsibility, it only produced 300 pieces. The

performance per piece in this process is (500/300), and it shows a deficit. However, when the stock-out is due to another's responsibility, this process can only produce 300 pieces as a result. In this case, the process will be evaluated at the time P hours required to make 300 pieces. The performance per piece in this process is (P/300). The company will compensate this process for the delayed time (X-P) hours, and this process will utilize the compensation time for improvement, education and training."

[11] The "J" in J-cost theory means Just in Time. As to why the word "cost" remains in J-cost theory, according to the e-mail interview with Professor Tanaka conducted by the author on 24 August, 2010, "since cost reduction has been engaged for decades, there is little room for it at the local level. However, for the purpose of raising profits, the target reduction amounts are assigned repetitively. The timid operating manager who doesn't endure the pressure cuts down educational time under the plea for improvements. The communication time is cut down. The examination time for tools and equipment is cut down. And then work is neglected in the end. The shop floor was plunged into the depths of inability. Instead of reducing the costs, the J-cost should be reduced, that is why the word 'cost' is kept in J-cost theory."

[12] Resembling the calculating formula of J-cost, there are throughput-dollar-days (TDD) and inventory-dollar-days (IDD) in TOC theory. But TDD and IDD are different from J-cost. TDD is designed to measure late shipments by their dollar value multiplied by the number of days the shipment is late. TDD is a delivery performance measurement (Goldratt, 2000). IDD multiplies the value of inventory by the number of days it stays under the plant responsibility (Goldratt, 2000). IDD is an inventory performance measurement. TDD and IDD focus on the degree of deviation from the plan and basically judge the quality of the execution of the plan.

[13] It is possible that the costs are input during the process, and not necessarily input at the beginning of the process. Here, the average costs at the beginning and the ending of the process are used. It is also possible to calculate J-cost in integral as follows:

$$\text{J-cost} = \int C(t)\,dt \ (\text{Euros*Day})$$

[14] These two examples refer to Tanaka (2004, 2008).

[15] During the 2008 financial crisis stemming from USA, Toyota was pressed secondarily to downsize its performance forecast for the fiscal year 2008 on 22 December, 2008. This was called "Toyota Shock." Toyota had extended its operating income through production expansion and recorded the highest operating income (2,270 billion yen) for the fiscal year 2007. However, the operating loss was 461 billion yen for the fiscal year 2008.