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A Study on the Moderating Effect of Inventory Items on the Relation between Quality Support Activity and Quality Performance

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Abstract

Objectives: When taking the activity of quality support for Small and Medium-sized Enterprises (SMEs), large companies have selected SMEs, established the same goal of quality activity and performed quality support activity based on strategic importance and transaction amount, without any review of inventory item types. If inventory item types are taken into account in selecting SMEs and quality support activity is differentiated, the activity performance can be maximized. **Methods/Statistical Analysis:** Based on the cases of large companies' quality support activities for SMEs, this study analyzed the activity performance statistically, categorized inventory item types into single item, complex item and finished product. It investigated the quality performance between the 1st half-year and 2nd half-year after the quality support activity, on the basis of the 1st half-year before the quality support activity. **Findings:** First, after large companies' quality support activity for SMEs, single items that are supplied to large companies, showed high performance improvement. Secondly, single items led to a fast improvement in quality performance. **Improvements/Applications:** If it is expected to make a big performance improvement in a short time, it is required to cooperatively take quality support activity based on short-term projects for SMEs that have business of single items. But for SMEs that have business of complex items and finished products, it is required to take quality support activity from a long-term perspective. This study results will contribute to minimize trials and errors and maximize the performance of quality support activity through selection and concentration when large companies have quality support activity for SMEs.

Keywords: Inventory Item Types, Quality Performance, Quality Support Activity

1. Introduction

As an industrial structure gets more advanced, the added-value creation of large companies tends to be of little importance, whereas that of Small and Medium-sized Enterprises (SMEs) tends to be of great importance. According to[1], in the manufacturing industry, the quality of middle parts determines the quality of a manufacturer and therefore the cooperation with outsourcing firms that manufacture middle parts is directly related to corporate competency. In other words, not only large companies' product development competency and production competency, but SMEs' competency of supplying parts is closely related to large companies' competitiveness. Large companies play their role for finished products, such as final assembly and security of the reliability of product quality, whereas SMEs serve their function for single parts. The production activity of SMEs gradually expands to complicated items, making finished products through OEM. In[2] reported that among the qualification factors for business with large companies, the quality level of items becomes the most important factor. Basically, firms that manufacture parts or products need to perform the activity of increasing a quality level on their own. Nevertheless, SMEs have actual limits because of their relative lack of resources and competency. Therefore, large compa-

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nies select the firms that need to improve a quality level among their business partners and use quality experts to perform the activity of quality support. However, without any detailed review of the characteristic factors of SMEs, they have selected the firms to support on the basis of strategic importance and business transaction amount, established the goal of quality activity equally and performed the quality support activity in a unified activity period and method. In addition, once a goal is achieved, they generally wrap up the activity as success. Therefore, this study tries to suggest the characteristic factors that must be taken into account for SMEs' quality support activity.

The partnership between firms helps to improve mutual performance of supply chain partners and keep friendly relationship and firms realize their performance by making efforts to solve their common problem[3]. To improve partners' performance, they perform qualtiy support activity and establish common problem solution teams for constant cooperation[4]. According to[5], to secure large companies' competitiveness, it is favorable to use their competency and support the competency enhancement of SMEs in a long-term perspective and it is possible to improve the quality and productivity of SMEs depending on large companies' interest and intention. In[6] argued that cooperation activity using external network brings about quality innovation and customer satisfaction. It is said that the cooperation activity positively influences the quality performance of relevant SMEs. In[7] reported that to achieve the common goal of organizations, collaboration ability should be excellent. That is why the quality support activity is needed for quality innovation, the common goal of both large companies and SMEs. According to[8], large companies' activities for SMEs, such as quality education, parts improvement activity and support for management method positively influence the quality performance of SMEs. In[9] said that the more quality cooperation between firms, the better financial performance and quality performance. In[10] reported that the organic cooperation system of quality and technical information between large companies and SMEs helps to improve the quality performance of SMEs. According to[11], of the activities supported by large companies, quality support activity accounts for 65.8% and SMEs' preference ratio of quality support activity reaches 53.6%. Given that, quality support activity is put before other activities. According to the research on cooperation of automobile parts firms by[12], assembly firms that secure resources and competency should continue to take the activity of quality support for small-sized parts firms and the support can lead to improved quality of both parts and finished products. Therefore, the activity of quality support for enhancing quality competitiveness of SMEs is a key to the establishment of cooperation between large companies and SMEs and should continue to develop further.

2. Case of the Quality Support Activity Taken by D Large Company

D large company that manufactures industrial electricity products has performed the activity of quality support for its 38 SME partners over the last 1 year as shown in Figure 1 by making use of quality experts. The SMEs was selected based on high strategic importance and a high amount of business transaction. Before the quality support activity, the management level and problems of the SMEs had been analyzed for 1 month. In accordance with activity plan, instruction activity was performed.

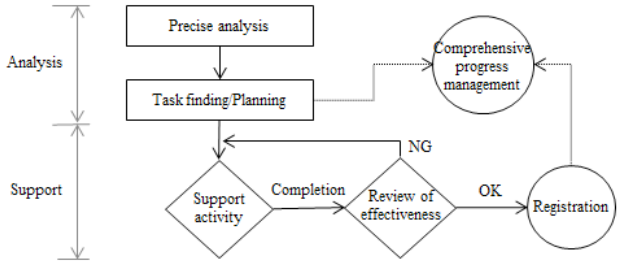

Figure 1. Quality support activity process of D large company.

3. Research Model and Hypotheses

3.1 Research Model

In this study, inventory item types supplied to large companies were set to a moderating variable and comparative analysis was conducted to find how a large company's quality support activity influences the quality performance of SMEs. Mostly, the manufacturing industry has a basic production process as follows: Raw materials are used for making a single item; a complex item is made

from assembling various single times; a final finished product is made from assembling diverse complex items. Large companies mainly receive complex items to manufacture finished products and some take single items or complex items. Firms that make single items focus on the compliance with basic specifications for production. Firms that make complex items not only follow specifications, but have responsibility for the quality of complex items. Therefore, engineering knowledge and experience is additionally needed so that such firms take on challenge to reach higher level[13]. Therefore, it is expected that the performance of quality support activity will be differentiated depending on inventory item types. This research model is presented in Figure 2.

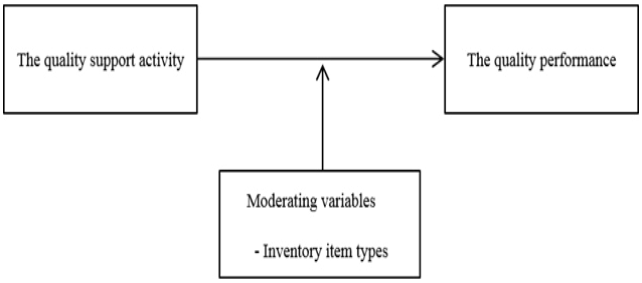

Figure 2. Study model.

3.2 Establishment of Hypotheses

According to[14], the quality management of single items focused on appearance and dimensions based on drawings; but the assembled single item has complicated structure and because of quality issue of diversified properties, it is not easy to simplify dimension properties. According to the research on automobile parts by[15], firms that make complex items need overall system technology (including design technology) and the managing ability for parts suppliers and firms that make single items need to enhance their manufacturing technology. Single item is focused on the appearance quality such as dimensions and surface state. Therefore, improvement activity of single items is performed in relatively narrow aspects, such as raw material check, mold improvement and equipment condition adjustment. Once the cause of a failure is removed, quality performance improves immediately. Single items are produced massively and thus a quality improvement activity contributes to direct quality performance. Complex items and finished products include the concept of assembly of items so that quality control is complicated. For the reason, although single items are improved, it is possible to cause an unexpected quality problem in the process of assembling different types of single items. Therefore, there is a limitation to the immediate influence on quality performance. Given all, single items feature relatively simple quality control, large influence on quality performance and an immediate change in quality performance. Complex items and finished products have many quality control issues and complicated interaction so that, compared to single items, they hardly

Table 1. Construct and operational definition of variables

Construct	Conceptual Definition	Operational Definition
Quality support activity	A large company's activity for improving the quality level of SMEs	The activity of checking that quality system runs well in line with a firm's size and characteristics and of suggesting a proper method. The activity of suggesting better ways from the perspective of components (products) quality, in terms of work method, check method, and storage and transfer method, and of instructing improvement process.
inventory type of items	A type of items that are supplied to a large company by SMEs	A single item means a unit item, such as a machine material and a cutting material. A complex item means the assembled item with small items in standardized and functional-unit process. For improving assembling feature and productivity, complex items are supplied. A finished product means the item equipped with its unique performance and function. It can be sold in the market.
Quality performance	Quality level of SME	A quantity of non-conformity items found by a large company's take-over check and process check, among SME's components (products) supplied to a large company. Ratio of defects in a million (PPM).

influence quality performance and feature a slow change in quality performance. Therefore, this study established the hypotheses as follows:

- Hypothesis 1. Regarding the effect of a large company's quality support activity for SMEs, the simpler an item supplied to a large company is, the larger a change in quality performance is found.
- Hypothesis 2. Regarding the effect of a large company's quality support activity for SMEs, the simpler an item supplied to a large company is, the faster a change in quality performance is found.

3.3 Study Method

3.3.1 Operational definition of variables

The main variables of this study are quality support activity, an inventory type of items and quality performance, as shown in Table 1.

3.3.2 Study Subjects and Sample Characteristics

Table 2 shows the sample characteristics of 38 SMEs to which D large company's quality support activity was applied.

3.3.3 Control of Exogenous Variables

For control of exogenous variables, the quality indexes at the first half-year and second half-year points before quality support activity were compared to check the trend. The purpose is to find that if quality tends to be improved before quality support activity, it is improved either by quality support activity or by the trend. The group of SMEs that supply single items to the large company (single item group) had –0.470 ($p = 0.645$) of t-value; the group of SMEs that supply complex items (complex item group) had 0.815 ($p = 0.429$); and the group of SMEs that supply finished products (finished product group) had –0.538 ($p = 0.607$). At a significance level of 5%, the three groups were not statistically significant. Therefore, there was no trend of quality improvement before quality support activity.

3.4.4 Analysis Method

As a study tool, the paired t-test of SPSS was used to analyze the difference in quality performance before and after quality support activity. Based on the half-year right before quality support activity (the 1st half-year before the activity), this study conducted a comparative analysis in the unit of self-year and examined the effectiveness of quality performance.

4. Empirical Analysis and Hypothesis Test Result

4.1 Hypothesis Test

4.1.1 Test Result of hypothesis 1: A Level of a Change in Quality Performance Depending on an Inventory Type of Items

As illustrated in Figure 3, the single item group had 613 PPM in the 1st half-year before the activity, 416 PPM in the 1st half-year after the activity and 395 PPM in the 2nd half-year after the activity and therefore, the change of 32.1% and 35.6% was found respectively. The complex item group had 696 PPM in the 1st half-year before the activity, 571 PPM, in the 1st half-year after the activity and 496 PPM in the 2nd half-year after the activity. Therefore, the change of 18.0% and 28.7% was found respectively. The finished item group had 368 PPM in the first half-year before the activity, 320 PPM in the 1st half-year after the activity and 320 PPM in the 2nd half-year after the activity and therefore, the change of 13.0% was found respectively. As a result, it was found that the simpler an item supplied to a large company was, the larger a change in quality performance was found.

Table 2. Sample characteristics of SMEs

Category		Frequency	Rate
inventory type of items	Single item	15	39.5%
	Complex item	15	39.5%
	Finished product	8	21.0%

4.1.2 Test Result of Hypothesis 2: A Speed of a Change in Quality Performance Depending on an Inventory Type of Items

As shown in Table 3, the single item group had 416 PPM in the 1st half-year after the activity, 197 PPM down from the PPM value in 1st half-year before the activity. The difference t-value was 2.904 ($p = 0.012$), which was statistically significant at a significance level of 5%. As

displayed in Table 4, the group had 395 PPM in the 2nd half-year after the activity, 218 PPM down from the PPM value in 1st half-year before the activity. Therefore, the difference t-value was 3.192 (p = 0.007), which was statistically significant at a significance level of 5%.

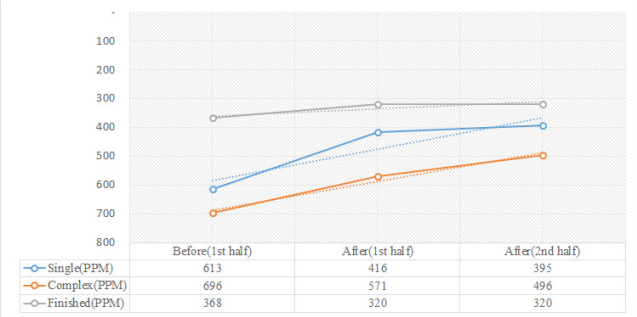

Figure 3. A change in quality performance by an inventory type of items.

Table 3. Single-item first half year after activity

Result Index	Before (1st half)	After (1st half)
Average	613 PPM	416 PPM
Standard Deviation	628	466
Average Differential	197 PPM	
T-value	2.904	
Double-tail p-value	0.012	

Table 4. Single-item second half year after activity

Result Index	Before (1st half)	After (2nd half)
Average	613 PPM	395 PPM
Standard Deviation	628	458
Average Differential	218 PPM	
T-value	3.192	
Double-tail p-value	0.007	

As shown in Table 5, the complex item group had 571 PPM in the 1st half-year after the activity, 125 PPM down from the PPM value in 1st half-year before the activity. The difference t-value was 1.790 (p = 0.095), which was not statistically significant at a significance level of 5%. However, as displayed in Table 6, the group had 496 PPM in the 2nd half-year after the activity, 200 PPM down from the PPM value in 1st half-year before the activity. The difference t-value was 2.376 (p = 0.032), which was statistically significant at a significance level of 5%.

Table 5. Complex item first half year after activity

Result Index	Before (1st half)	After (1st half)
Average	696 PPM	571 PPM
Standard Deviation	604	553
Average Differential	125 PPM	
T-value	1.790	
Double-tail p-value	0.095	

As shown in Table 7, the finished product group had 320 PPM in the 1st half-year after the activity, 48 PPM down from the PPM value in 1st half-year before the activity. The difference t-value was 1.235 (p = 0.256), which was not statistically significant at a significance level of 5%. As displayed in Table 8, the group had 320 PPM in the 2nd half-year after the activity, 48 PPM down from the PPM value in 1st half-year before the activity. The difference t-value was 1.577 (p = 0.159) which was not statistically significant at a significance level of 5%.

Table 6. Complex item second half year after activity

Result Index	Before (1st half)	After (2nd half)
Average	696 PPM	496 PPM
Standard Deviation	604	463
Average Differential	200 PPM	
T-value	2.376	
Double-tail p-value	0.032	

Table 7. Finished product first half year after activity

Result Index	Before (1st half)	After (1st half)
Average	368 PPM	320 PPM
Standard Deviation	214	241
Average Differential	48 PPM	
T-value	1.235	
Double-tail p-value	0.256	

Table 8. Finished product second half year after activity

Result Index	Before (1st half)	After (2nd half)
Average	368 PPM	320 PPM
Standard Deviation	214	231
Average Differential	48 PPM	
T-value	1.577	
Double-tail p-value	0.159	

Given all results, the single item group has shown a significant change since the 1st half-year after the activity; the complex item group has shown a significant change since the 2nd half-year after the activity; the finished product group didn't show any significant change until the 2nd half-year after the activity. In other words, it was found that the simpler an item supplied to a large company was the faster a change in quality performance was found.

5.2 Discussion of Hypothesis Test Result

Regarding the effect of a large company's quality support activity for SMEs, the simpler an item supplied to a large company was, the larger and the faster a change in quality performance was found. It is necessary to establish a quality support plan and take the quality support activity in a differential way depending on an inventory type of items. More specifically, for SMEs supplying single items, it is desirable to take the activity of improving work conditions for mold and equipment and the appearance quality including dimensions management efficiently in a short time. For SMEs supplying complex items, it is necessary to take into account assembling feature and productivity of parts and designs. For SMEs supplying finished products, it is suitable to provide a wide range of activity to help them secure product performance and reliability. Accordingly, to maximize the effect in a short period of time, it is desirable to focus on the quality support activity for SMEs supplying single items and to help to solve complicated problems of SMEs supplying complex items and finished products solve complicated problems from a long-term perspective. In particular, although SMEs supplying complex items and finished products have no quality performance in a short term, it is important to take support activity continuously.

5. Conclusion

5.1 Study Summary and Suggestions

This study revealed that the effect of a large company's quality support activity for SMEs was different depending on an inventory type of items supplied to the large company, which is one of SMEs' characteristic factors. Regarding the effect of a large company's quality support activity for SMEs, the simpler an item supplied to a large company was, the larger and the faster a change in quality performance was found. If it is expected to big performance improvement in a short time, it is required to cooperatively take quality activity based on short-term projects for SMEs that have business of single items. However, for SMEs that have business of complex items and finished products, it is required to take quality support activity from a long-term perspective.

This study is meaningful in the point that it statistically analyzed the effect of a large company's quality support activity for multiple SMEs and examined the differentiation of the moderating factor. This study results will contribute to minimize trials and errors and maximize the performance of quality support activity through selection and concentration when large companies have quality support activity for SMEs.

5.2 Study Limitations

This study has limitations to the number of data samples and a research period. It has a limitation in generalizing the results of the analysis with 38 SMEs. Since it analyzed the quality performance found during two half-year periods after quality support activity, it was impossible to draw results from a long-term perspective. Therefore, it is necessary to analyze and monitor how long the effect of quality support activity lasts accurately. In the future, it will be necessary to research the moderating variable that affects the effect of quality support activity and to study the relation between SMEs' competency and size.

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