제조업의 성과측정 시스템 특성에 관한 탐색적 연구

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Abstract

We present an early result of a research for formalization of the characteristics and effectiveness of manufacturing performance measurement systems (PMS). Recently manufacturing PMS has been a focus of broad research efforts due to its practical role playing in managers' decision making process. There have been so many suggestive researches that explain the troubles with old cost accounting-based PMS and describe the desirable properties of PMS in strategic management of manufacturing operations. The lack of empirical investigation in this area, however, has left us unsure about what are the real characteristics that distinguish one PMS from another.

In this paper, we propose a conceptual framework that can be used to describe the environment in which a specific PMS works, the characteristic and the utilization variables of a PMS. Then we report the result of a field survey, where we found three distinctive characteristics of a PMS, contents, vertical integration, and horizontal integration. Further, we discuss the relationships of the variables with the utilization of PMS, manufacturing strategy, manufacturing improvement programs, and business performance.

1. Introduction

Recently manufacturing PMS has been a focus of broad research efforts due to its practical role playing in managers' decision making process. Frequent failures of manufacturing improvement programs have been noted as a natural consequence of inadequate PMS. There have been so many suggestive researches that explain the troubles with old cost accounting-based PMS and describe the desirable properties of PMS in strategic management of manufacturing operations. The lack of empirical investigation in this area, however, has left us unsure about what are the real characteristics that distinguish one PMS from another. In this context, we intend to clarify conceptual characteristics of PMS so that they can be used to evaluate existing systems and can serve as a starting base to develop a contingency theory explaining the effectiveness of PMS.

2. Theoretical Background

Literally performance measurement is the process of quantifying action, where measurement is the process of quantifying and action leads to performance. And performance measure is a metric used to quantifying action. Also PMS is the sets of metrics used to quantify action (Neely et al., 1995). Many researchers have discussed the definition of PMS, but there appear to be few studies on the physical configuration of PMS. Neely et al.(1995) proposed a simple framework for the structure of PMS, which separates the individual performance measures, the set of performance measures (PMS as an entity), and the relationship between the PMS and the environment within which it operates.

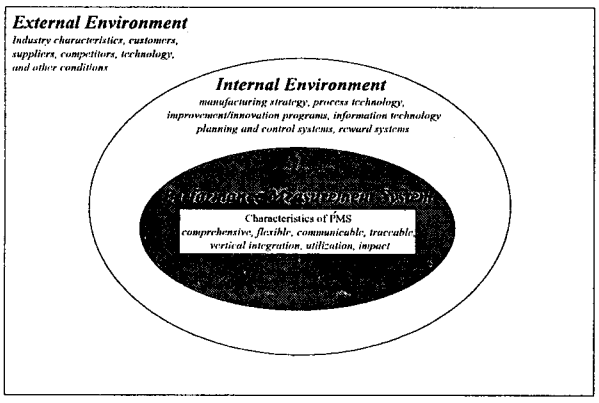
All PMS consist of a number of individual performance measures. There are various ways by which these performance measures can be categorized, ranging from Kaplan and Nortons(1992) balanced scorecard through to Fitzgerald et al.s(1991) framework of results and determinants. The rationale is that performance measures need to be positioned in a strategic context, as they influence what people do. Measurement may be the process of quantification, but its effect is to stimulate action, and as Mintzberg(1978) has pointed out, it is only through consistency of action that strategies are realized. Simons(1991) extends the notion that performance measures can be used to influence behavior. He argues that management control systems can also be used as a means of surveillance, motivation, monitoring performance, stimulating learning, sending signals or introducing constraints. In the organizational behavior literature, the link between control and strategy is less explicit, although there is widespread recognition that PMS can be used to focus activities (Erban, 1989; Fowler, 1990). Also in the manufacturing and management accounting literature, performance measurement is seen as a primary means of inducing consistency of decision making and action (Kaplan, 1990; Hall et al., 1991). It is frequently argued that performance measures should be derived from strategy; that is, they should be used to reinforce the importance of certain strategic variables. In summary, there appear to be wide agreement with Mintzbergs thesis (1978) that strategy is realized through consistency of decision making and action.

Performance measurement framework is a principle to integrate different dimensions of performance and enables PMS to provide sufficient information. Many researchers have proposed various performance measurement frameworks for integrated PMS. (De toni and Tonchia, 1996; Fitzgerald et al., 1991; Flapper et al., 1996; Kaplan and Norton, 1992; Keegan et al., 1989) Despite the categorical difference among the frameworks, the baseline of these works are; 1) categorizing various measures, 2) emphasizing the inclusion of non-financial measures, and 3) balancing or integrating the categories of the performance measures.

The rapid changes of the environments affect greatly the business performance and lead to the strategic changes of the business. In this context, the PMS's roles may be defined as the media that transfer the change of the strategies all over the organizations and as the censors that monitor how fast to respond to these changes. Therefore the relationships among the environments, business, and PMS are very important.

There are two fundamental dimensions to the environments around PMS. One is the external environment that surrounds the organization such as customers, the structures of the industry, and competitors, and so on. The other is the internal environment within the organization such as business strategy, manufacturing process and information technology, etc.

For a PMS to be effective, it must be configured according to the external and internal environments, and it should be well understood throughout the organization. Finally the measurements have to be linked to the reward system to influence the people's behavior. We summarize the lessons and conclusions about the desired characteristics of PMS from existing research as follows. 1) The measures included should be comprehensive and responsive to the internal and external environments. 2) The measures should be integrated over the organizational hierarchy so that the upper level managers can use a few aggregated measures to understand the lower level operations. 3) The measures should be integrated over major business processes for the cause-effect relationship along the process to be clearly understood. 4) The measures and the PMS should be clearly defined and communicated throughout the organization. 5) The measures should be utilized to improve the performance of the organization and should be linked to the reward system. Figure 1 depicts the basic structure of our framework.



[Figure 1] Framework for the Analysis of PMS

3. Methods

As a unit of analysis in this research, manufacturing business unit (MBU) defined by Miller and Roth (1994) was used. Each MBU in the sample was either a single-plant company or an independent business unit with multiple plants. The questionnaires were mailed to managers in 1,100 MBUs. Responses were from 235 firms (21 percent response rate) across 22 industry categories in Korea. But 35 responses were determined to be inadequate mainly because they left too many missing values. The sample used in the study represents the nation's manufacturing sector without significant bias. The questionnaire consists of four sections; the external environment, the internal environment, the internal characteristics of PMS, and finally the usage of PMS. The external environment affects a firms strategy and organizational arrangements in various ways. We decided that the change and complexity of an industry where a firm competes are the most important dimensions of external environment. Dess and Beard (1984) developed three factors of business environment; munificence, dynamism, and complexity, of which we adopted the last two.

The internal environment of PMS may be many things, but we used the three most researched variables to characterize an MBU's manufacturing task and strategy; the competitive priority, the improvement programs, and process types. Ten competitive dimensions were selected to measure priority or strategic importance; performance and conformance quality, product features (3 quality dimensions), dependability and fast delivery, new product introduction, broad product line, and volume flexibility (5 time and flexibility dimensions), and finally product price and cost control capability (2 cost dimensions). In order to characterize manufacturing improvement or innovation programs, four distinct dimensions have been taken into consideration. They are 1) major source of improvement (human effort or new technology), 2) primary mover (manufacturing floor or overhead staff), 3) major target for change (product, process, or entire organization), and 4) major results from the initiatives (outside certificate or recognition).

The PMS variables were categorized into two groups; internal characteristics and utilization. The former deals with the configuration of measures and system characteristics, that is, internal structuredness, flexibility or responsiveness to environmental change, communicability, and hierarchical support. The latter is about the utilization characteristics of PMS in the MBU, that is, the usefulness of PMS for general management activities and its organizational impact.

Factor analysis is used to check that each scale is unidimensional, thus providing evidence of a single latent construct (Flynn et al., 1990). For business environment, 10 variables are reduced to three factors, which shows that the business environment can be divided into three dimensions. It shows that dynamism can be divided into technology dynamism and market dynamism in practice.

For internal characteristics of PMS, 17 variables were originally reduced to three factors. Because factor 3 included only one variable, the communicability item of 'common definition and interpretation,' we deleted it and retried the procedure. The remaining 16 variables are reduced again to three factors, the resulting factor loadings after a varimax rotation are shown in Table 1. The results are apparently quite different from the original classification of items. The factor 1 includes items representing measure structure and responsiveness of PMS to change. So we labeled it Contents of PMS. Factor 2, labeled Hierarchical integration, is made up of variables related to hierarchical structure of PMS; disaggregation and integration along hierarchy and support of management according to level. Factor 3 consists of items in communicability and traceability, so this can be interpreted as Horizontal integration across the functions. For utilization of PMS, 8 variables were

<Table 1> Factor Analysis for the Internal Characteristics

Variables	Factor 1	Factor 2	Factor 3
Items	Contents	Vertical integration	Horizontal integration
Customer driven measures	0.6139*	0.2728	0.3414
Linkage of customer measures to financial performance	0.7776*	0.1652	0.2013
Linkage of operational measures to customer measures	0.6429*	0.3058	0.1607
Changing measures by market condition or managerial strategy	0.6009*	0.4645	0.0671
Changing measures by improvement or innovation programs	0.7226*	0.2630	0.1840
Actual change of important measures in one year	0.7266*	-0.0793	0.3079
Goal disaggregation	0.3433	0.5202*	0.2683
Measure integration along hierarchy	0.4166	0.6718*	0.1843
Lower level support by easy-to-see tools	-0.0881	0.5048*	0.4033
Middle-level support by performance summary	0.1879	0.7886*	0.2849
Top management support by aggregated reports	0.2899	0.7759*	0.2204
Traceability of outcome measure to the causes	0.3629	0.3121	0.5780*
Acceptance of measure across the functions	0.2411	0.1478	0.5831*
Periodic review of quantified non-financial measures	0.2107	0.1520	0.7743*
Easy to understand	0.1066	0.3731	0.5440*
Integration and management by formal MIS	0.2279	0.1826	0.5550*
Engenvalue	6.7757	1.3426	0.9977
Percent of Variance	42.3	8.4	6.2
Cumulated percent of variance	42.3	50.7	57.0
Cronbach alpha	0.8510	0.8165	0.7488

<Table 2> Factor Analysis for the Utilization

Variable	Factor 1	Factor 2
Items	Practical usefulness	Org. impact
Helpful for management activities	0.9014*	0.1148
Helpful for vertical communications	0.8567*	0.1496
Helpful for horizontal communications	0.8983*	0.1929
Useful for competitive benchmarking	0.8131*	0.2139
Directions for improvement	0.7981*	0.1827
Basis of worker compensation	0.0847	0.8126*
Basis of worker promotion	0.1633	0.8622*
Basis of inter-functional conflict resolution	0.5161	0.5559*
Eigenvalue	4.5141	1.3018
Percent of Variance	56.4	16.3
Cumulated percent of variance	56.4	72.7
Cronbach alpha	0.9212	0.6978

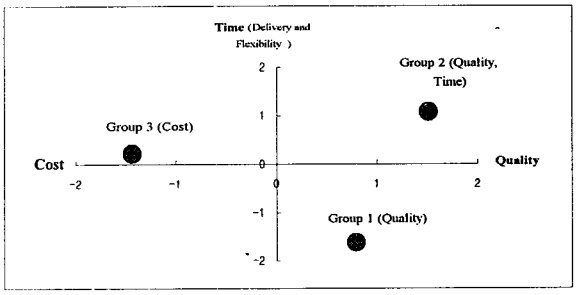
reduced to two factors (Table 2). The only difference from original construct is that the directions for improvement item in impact is classified into factor 1, apparently practical usefulness. We label the factor 2 organizational impact as before. As for the reliability, Cronbach coefficient alpha is calculated for each variable was calculated.

4. Analysis and Discussion

Cluster analysis is employed to identify the manufacturing strategy types from the respondent competitive priority profiles. In order to interpret the nature of the clusters, the clusters centroid is frequently used as the raw scores for the original variables (Hair et al., 1995). The results of one-way ANOVA test show that average scores in 10 competitive dimensions by cluster are not same at 5% significance level.

The ten taxons used to form the manufacturing strategy groups, however, are correlated with each other. Therefore in order to interpret the clusters, multiple group discriminant analysis is used in this study. In Figure 2, the groups on the plot indicate the centroids of the manufacturing strategy group assignment designated by the clustering procedure. It is clear that the group 1 competes on high quality and low cost. And the group 2 is likely to compete on high quality, fast delivery, and high flexibility, whereas the group 3 seems to compete on low cost, fast delivery, and high flexibility. The difference of manufacturing strategy between the group 1 and the group 2 can be explained by the time and flexibility emphasis, and that between the groups 2 and 3 can be considered as a trade-off perspective in effect between cost and quality.

Now we consider the association between business environment and manufacturing strategy, which is tested via pairwise t-test of the average scores between manufacturing strategic groups. The group 2 that is competing on quality, time, and flexibility faces turbulent business environments in terms of technology dynamism, market dynamism, and



[Figure 2] Group centroids in discriminant space

market complexity. Compared with the group 2, the group 3 competing on cost instead of quality is in a relatively stable business environment, whereas the group 1 is in the middle. This leads us a quite natural explanation that the firms in turbulent environment are trying harder, to become more competitive in more than just one dimension.

Next we consider the associations between manufacturing strategy and characteristics of PMS, which is tested via one-way ANOVA. Internal characteristics of PMS do are affected by manufacturing strategy significantly, although we can see a slightly high numbers in Group 2. This result reflects the reality of PMS, that is, more advanced manufacturing strategy (say, that of Group 2) is not supported by distinct PMS. The relationship between manufacturing process technology and characteristics of PMS is similarly tested. The results indicate that line flow process has more vertically integrated PMS at 5% significant level. Although other relationships are not significant, line flow process tends to have more

systematic PMS than other process types.

Manufacturing improvement and innovation programs are expected to affect the characteristics of PMS. As noted before, we measured the improvement programs by multiple measures, source and mover, programs and results. Table 3 confirms the conjecture. In other words, the firms pursuing improvement by new technology and outside experts tend to have more integrated PMS. Further, the firms with specific improvement programs and/or outcomes have more systematic PMS than the firms without those programs.

<Table 3> Improvement Sources and PMS

	Mfg. Imp./Inn. Programs	
	Sources	Movers
Contents	0.3218[a]	0.1741[b]
Vert. integration	0.2496[a]	0.2121[a]
Horiz. integration	0.2631[a]	0.2887[a]

a, b: significant at 1% and 5%, respectively

We can expect that more systematic PMS will be more useful and have greater organizational impacts. Table 4 shows the results of correlation analysis, which indicate that all variables in characteristics of PMS are strongly correlated to all variables in utilization of PMS.

<Table 4> Characteristics and Utilization of PMS

	Contents	Vertical integration	Horizontal integration
Practical usefulness	0.6348[a]	0.7344[a]	0.6439[a]
Organizational impact	0.4263[a]	0.4170[a]	0.4760[a]

a: significant at 1% level

Finally, and most importantly we examine whether the utilization of PMS can lead to better business performances. The results of correlation analysis in Table 5 indicate that all variables in utilization of PMS are positively correlated to all variables in business performance. Since our sample is relatively large, the strong significance is less important here. But we can safely argue that if PMS is systematic and practically helpful, then it can be a good influence on the bottom line of the firm.

<Table 5> PMS Utilization and Biz. performance

	Usefulness	Impact
Return	0.3110[a]	0.1844[a]
MS Growth	0.3630[a]	0.2398[a]

a: significant at 1% level

5. Conclusions

This research intended to clarify the characteristics of PMS for the firms to be able to diagnose or redesign their PMS in practice. We developed a new framework that can illustrate the relationships among factors around PMS. Through an exploratory field survey, we could obtain the following conclusions on the characteristics and relationships of environments, PMS, and business performances. First, PMS can be characterized by three variables: contents, vertical integration, and horizontal integration. A systematic PMS must reflect business goals hierarchy and every measure in the system should be integrated along the hierarchical level and across the functions.

Second, we introduced the external and internal environments of a PMS, which may affect the characteristics and effectiveness of PMS. This framework may serve as a practical guideline for developing or renovating a PMS as well as a theoretical backbone, around which more refined variables and relationships can be developed.

Third, we investigated the relationships between the environments and characteristics of PMS. We found that, in general, turbulent environment requires firm to be more aggressive in manufacturing strategy, and more advanced firms tend to have more systematic PMS. In a sense, what we mean by "systematic" seems quite related to formalism. This requires more research.

Fourth, we clarified the concept of PMS utilization and found that more comprehensive and integrated PMS will be more useful in practice. Finally, we investigated the effects of PMS utilization to business performance. A correlation analysis shows that a positive correlation between the two variables exists. This may be an explanation about the recent enthusiasm toward PMS both in academia and practice.

There are limits in this study, mainly due to the lack of formal studies about PMS characteristics. First, we used correlation analysis, and Small but significant correlation coefficients require close attention in interpreting the meaning. Second, many researches dealt with strategic business units (SBU) as an entity utilizing PMS, but in this research manufacturing business units (MBU) was a unit of analysis. Thus respondents' knowledge on internal manufacturing issues and external environmental issues may be of imbalance. Third, we selected only a few variables to study the PMS environments. Future research efforts will improve this problem.

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