THE FIT BETWEEN NEW PRODUCT STRATEGY AND VALUE CHAIN STRATEGY : A SYSTEM DYNAMICS PERSPECTIVE

Heungshik Oh and Bowon Kim

Graduate School of Management
Korea Advanced Institute of Science and Technology (KAIST)
207-43 Cheongryangri Dongdaemoon
Seoul, 130-012, Korea

ABSTRACT

New product development has been a key element for organizational evolution. The bulk of research about new product strategy has focused solely on new product development function itself. This paper investigates cross-functional elements in new product development. More specifically, we suggest that there must exist a fit between new product strategy and value chain strategy. It means that, in order to support new product development activity, there must exist a relevant value chain strategy. We consider three types of integration - internal integration, customer integration, and supplier integration - as strategic elements of value chain strategy. For the case of new product strategy, we consider market newness and product technology unfamiliarity as strategic elements. We also consider two types of learning characteristic, i.e., 'fast-adaptive learning' and 'slow-adaptive learning' as control factor. Learning characteristic represents firms' organizational capability related with organizational learning. For example, for fast-adaptive learning case, the effect of integration appears early in time. System dynamics simulation is employed to verify our research framework. The results exhibit that there must exist cross-functional relationships between value chain strategy and new product strategy in order to shorten total development time.

1 INTRODUCTION

Establishing new product strategy is an important activity in new product development. It is widely accepted that firms with public and systematic new product strategy exhibit superior performance [25]. The bulk of research about new product strategy has focused solely on new product development function itself. They mainly focus on deciding critical elements that lead to project success [1, 7, 8, 14].

Recently, in establishing new product strategy, new insight to link other functions besides product development together has appeared. Especially, value chain strategy is thought to play an important role for reinforcing the effect of new product strategy [11, 15].

This paper examines the fit between new product strategy and value chain strategy. More specifically, we have following research question - '*how value chain strategy can affect project performance in combination with new product strategy*?'

After reviewing relevant literature in the next section, we illustrate our research framework and system dynamics model in Section 3. Section 4 discusses results of simulation. Finally, conclusion and implication are presented in Section 5.

2 LITERATURE

For new product strategy, much research has been already conducted. They identify critical success factors that must be managed to succeed product development. According to previous research, new product strategy can be decomposed into several sub-strategies. First sub-strategy is related with product technology. It focuses on characteristics of product such as technological sophistication, orientation, and innovativeness [4, 5, 6, 16]. Second sub-strategy is related with market characteristics. It mainly focuses on market newness, growth, and competitiveness [1, 8, 9, 12]. Finally, third sub-strategy is related with organizational characteristics. It focuses on forming project organization such as resource allocation, decision sharing, and top management commitment [10, 19 27].

For value chain strategy, main research topic is how to organize and operate value chain. Value chain comprises all activities from upstream to downstream for delivering value-added products to customers. Many researchers endeavor to figure out effect of integration in value chain [2, 17, 18, 23]. Indication of high level of integration

would include increased coordination of logistics activities as well as increased communication between organizations [20]. Integration can be decomposed into two types of integration. One is internal integration and the other is external integration. Internal integration means the integration of activities within the firm [3, 24] while external integration means the integration of activities across firm boundaries [13, 26]. External integration is further decomposed into customer integration and supplier integration [21].

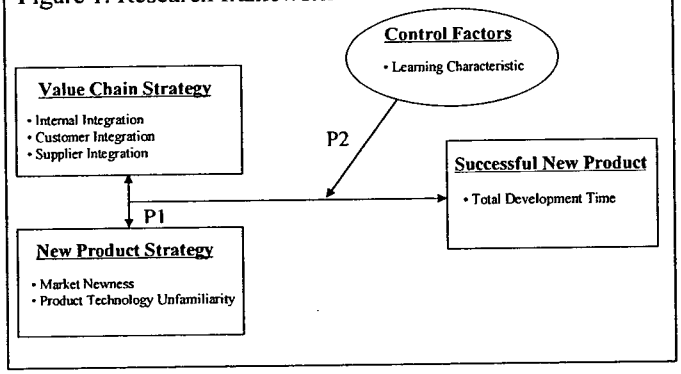
Both new product strategy and value chain strategy are very important elements in today's firms. Although these have been separated issues so far, some research to link these two issues together has emerged recently [11, 15, 22]. These researches imply that there must exist the fit between new product strategy and value chain strategy in order to obtain better performance.

3 RESEARCH FRAMEWORK

3.1 Research Model

In this section, we discuss our research settings and propositions. Figure 1 shows our research framework.

Figure 1. Research framework



We first consider three types of integration - internal integration, customer integration, and supplier integration - as elements of value chain strategy. Internal integration means the integration of activities within the firm and plays a role of increasing internal work-related capabilities such as design capability, manufacturing capability, and work force adjusting capability. Customer integration and supplier integration are considered as external integration. Customer integration means the integration of inter-firm activities between a firm and customers. Firms can gather customer and market related information by customer integration and this results in reducing market uncertainty. On the other hand, supplier integration means the integration of inter-firm activities between a firm and suppliers. Supplier integration plays a role of increasing supplying parts' quality. And more importantly, it also plays an important role of accumulating manufacturing technology from suppliers. So, firms can reduce manufacturing complexity due to product technology unfamiliarity by supplier integration.

For new product strategy, market newness and product technology unfamiliarity are considered. Market newness means whether the target product is entirely new one or not in market. On the other hand, product technology unfamiliarity means whether necessary technology is very unfamiliar to the firm or not.

We take into account total development time as performance measure. This measure is employed for the sake of convenience in our simulation model.

Finally, we consider learning characteristic as control factor. This represents firm's learning propensity. We take into account two types of learning characteristic, i.e., 'fast-adaptive learning' and 'slow-adaptive learning'. If firm's learning characteristic is 'fast-adaptive', then the effect of integration appears early in time. In other words, only small amount of integration can be sufficiently effective. This relationship can be formulated as concave function for positive effect, and as convex function for negative effect. On the other hand, if firm's learning characteristic is 'slow-adaptive', then the effect of integration appears lately in time. In this case, integration can only be effective when sufficient amount of integration is activated. This relationship can be formulated as convex function for positive effect, and as concave function for negative effect.

We first consider the fit between value chain strategy and new product strategy. For instance, when there exist certain amounts of market newness and product technology unfamiliarity, how three types of integration can affect total development time? This invokes us following propositions.

Proposition 1a. The newer the market, the more customer integration needed for reducing total development time.

Proposition 1b. The more unfamiliar the product technology, the more supplier integration needed for reducing total development time.

Proposition 1c. The older the market and the more familiar the product technology, the more internal integration needed for reducing total development time.

Proposition 1a explains the fit between market newness and customer integration. When there exist much market newness, firms face much uncertainty in relation to market information. So, in order to reduce market uncertainty, firms must devote themselves to customer integration. Proposition 1b has similar explanation.

Proposition 1c can be explained with somewhat different reasoning. When there exist little market newness and product technology unfamiliarity, neither customer integration nor supplier integration is needed to reduce uncertainty. In that case, internal integration can have a great effect on project completion.

The effects of three types of integration on project completion can be varied as firms' learning characteristics. We set following proposition.

Proposition 2. The effects of three types of integration would be much greater in fast-adaptive learning than in slow-adaptive learning.

Proposition 2 represents the controlling effect of learning characteristic on integration. For the case of fast-adaptive learning, only small amount of integration can be sufficiently effective and therefore total development time can be shortened compared with slow-adaptive learning.

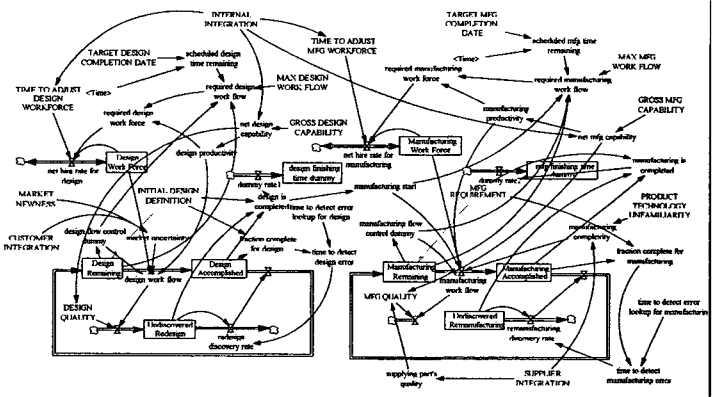
3.2 System Dynamics Model

In order to verify our research propositions, we employ system dynamics simulation. Figure 2 shows our system dynamics simulation model. The model consists of 2 parts. The first part is 'design' module, which corresponds to the left side of the model. And the second part is 'manufacturing' module as presented in the right side of model. Product development starts from design activity. At the beginning of design activity, there is initial design definition which indicates total amount of work needed. As design activity progresses, some amount of work can be judged as failure, which leads to rework. Firms can also adjust work flow level by hire and fire activities. Once design is completed, manufacturing activity is started as similar procedure.

Market newness and product technology unfamiliarity affect the model as new product strategic elements. If product development project has more market newness, then there exist more market uncertainty. Similarly, if project has more technological unfamiliarity, then there exist more manufacturing complexity.

Internal integration, customer integration, and supplier integration are deployed as value chain strategic elements and considered as decision making variables in the optimization model. Internal integration affects the work force adjustment time as well as net design and manufacturing capabilities. If the level of internal integration is more higher, then time to adjust work force is more shortened and net design/manufacturing capability is more increased. Customer integration plays a role of reducing market uncertainty while supplier integration plays a role of reducing manufacturing complexity.

Figure 2. System dynamics simulation model

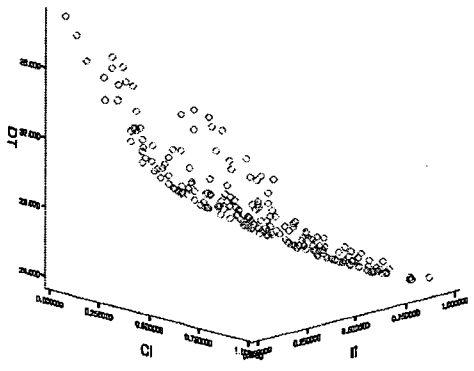


4 RESULTS

4.1 Basic Simulation Run

In order to observe the effects of three types of integration as a whole, we simulate the model at arbitrary level of market newness and product technology unfamiliarity. Figure 3 shows the effect of customer integration and internal integration on design finishing time by fixing both market newness and product technology unfamiliarity at 0.5 (all levels of integrations, market newness, and product technology unfamiliarity are assumed to have real values from 0 (very low) to 1 (very high)).

Figure 3. Effects of internal integration and customer integration on design finishing time



DT: design finishing time, CI: customer integration, II: internal

integration

As we expected, both internal integration and customer integration have positive effect on design finishing time. In other words, design finishing time decreases as level of customer integration and internal integration increases. Moreover, at the very high level of integrations, design finishing time is reduced dramatically to nearly half of initial amount with no integration. This means that both customer integration and internal integration have a great influence on reducing development time. More interestingly, the effect of each integration is not mutually exclusive but cross-functional. This means that levels of each integration must be decided concurrently not separately. This figure also ensures validity of our simulation model. Since we obtain similar figure for the relationship among manufacturing finishing time, supplier integration, and internal integration, we omit that figure.

4.2 Optimization Run

Basic simulation results show that the effects of three types of integration as a whole. But, this is not enough to verify our research propositions. Once three types of integration are declared to be effective, the next step must be deciding how to allocate available resource to three types of integration, given resource limitation. This calls for optimization run related with resource allocation.

We simulate optimization run with manufacturing finishing time – in our model, manufacturing finishing time equals total development time – as payoff and with levels of three types of integration as parameters to be decided. Because there always exits resource limit, we assume that the sum of three levels of each integration equals one.

Before examining the optimal composition of integrations, we investigate the effects of market newness and product technology unfamiliarity on total development time. Figure 4 presents the relationship between total development time and market newness for different learning characteristic by fixing level of product technology unfamiliarity at 0.9.

As Figure 4 illustrates, total development time increases monotonically as level of market newness increases for both types of learning characteristic. Also, fast-adaptive learning case always surpasses slow-adaptive learning case. Another interesting finding is that total development time for slow-adaptive learning case increases rapidly around 0.6 of market newness. This implies that the effects of integrations are remarkably weaker at higher level of market newness for slow-adaptive learning case. But for fast-adaptive learning case, total development time doesn't increase much as level of market newness increases. This means that, for fast-adaptive learning case, integrations are quite effective for all levels of market newness. Figure 5 presents the relationship between total development time and product technology unfamiliarity by fixing level of market newness at 0.9. This Figure shows similar feature with Figure 4.

Figure 4. Effect of market newness on total development time

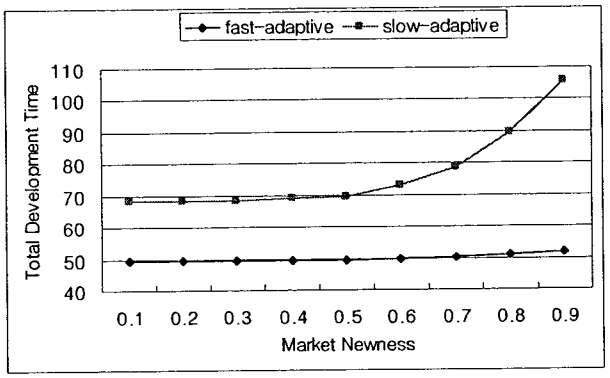
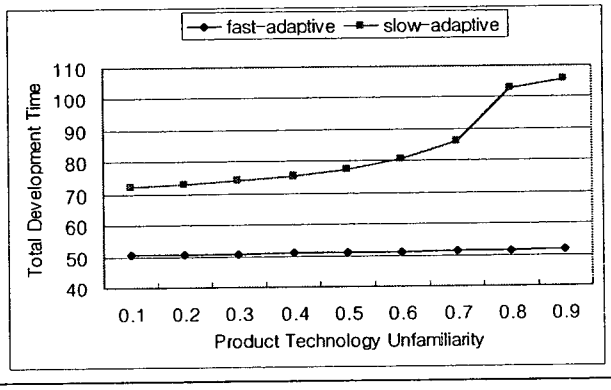


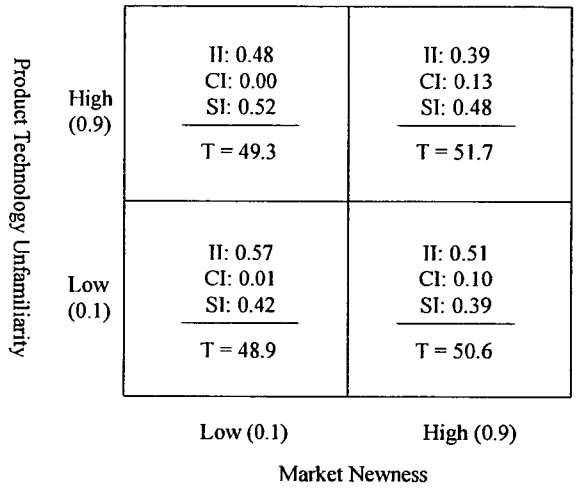
Figure 5. Effect of product technology unfamiliarity on total development time



In order to investigate optimal composition of integrations, we repeat simulation at various levels of market newness and product technology unfamiliarity. Results of optimization run are presented in Figure 6 for fast-adaptive learning case and in Figure 7 for slow-adaptive case.

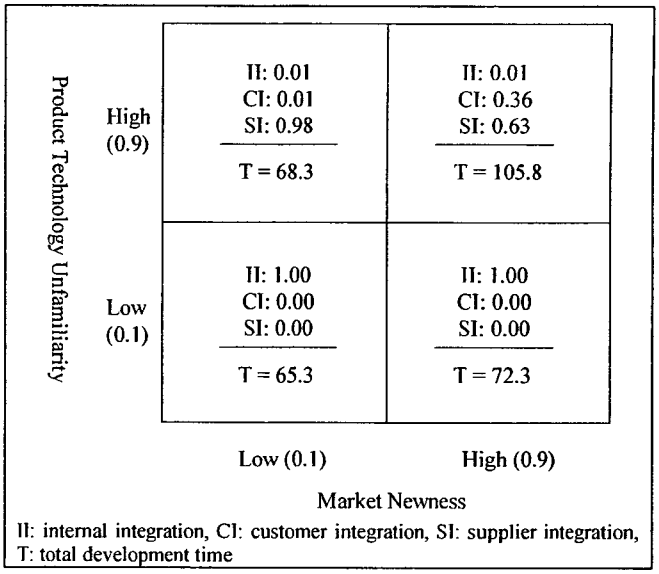
Figure 6 presents how to allocate overall resource to three types of integration in order to minimize total development time. For example, if both market newness and product technology unfamiliarity are high, then firms must allocate 39% of available resource to internal integration, 13% to customer integration, and 48% to supplier integration in order to minimize total development time. As Figure 6 illustrates, the optimal level of customer integration increases when there exists more market newness irrelevant with level of product technology unfamiliarity. Also, the optimal level of supplier integration increases when there exists more product technology unfamiliarity irrelevant with level of market newness. And, the optimal level of internal integration reaches to the highest value when there exist less market newness and product technology unfamiliarity. Additionally, it is another finding that the portion of customer integration is always smaller than others.

Figure 6. Results of optimization run when fast-adaptive learning is assumed



II: internal integration, CI: customer integration, SI: supplier integration, T: total development time

Figure 7. Results of optimization run when slow-adaptive learning is assumed



II: internal integration, CI: customer integration, SI: supplier integration, T: total development time

Figure 7 presents similar results except that the relationship between customer integration and market newness is not clear for low level of product technology unfamiliarity. In other words, for the slow-adaptive learning case with low level of product technology unfamiliarity, customer integration is not effective to reduce total development time. In that case, internal integration is the most effective element to reduce total development time irrelevant with level of market newness. This means that, for low level of product technology unfamiliarity, the effect of customer integration for reducing market uncertainty is much weaker than the effect of internal integration for reinforcing internal work-related capabilities such as design and manufacturing capabilities. These explanations ensure our propositions 1a through 1c, except that proposition 1a is partially supported for the fast-adaptive learning case only.

Proposition 2 can be easily accepted by comparing Figure 6 and Figure 7. According to these figures, total development time for fast-adaptive learning case is always smaller than that for slow-adaptive learning case. Another interesting finding is that, in the optimum, resource is relatively split into three types of integration for fast-adaptive case while it is concentrated on one of three types of integration for slow-adaptive case. The reason is that relatively small amount of each integration can be sufficiently effective for fast-adaptive case but not for slow-adaptive case. This is because of the very nature of learning characteristic. For slow-adaptive case, only small amount of integration cannot be effective at all and resource is relatively concentrated on the most effective integration. These explanations ensure our proposition 2 along with Figure 4 and Figure 5.

5 CONCLUSION AND IMPLICATION

In this paper, we examine the relationship between value chain strategy and new product strategy. The simulation results exhibit that there exist cross-functional relationship among three types of integration, new product strategic elements, and learning characteristic. This means that firms must control the level of integrations according to the characteristic of new product development project. It is another finding of this paper that the effect of integrations is much greater in fast-adaptive learning case.

The results of this paper give insight to both researchers and practicians. Value chain strategy and new product strategy are not separated issues but closely inter-related. According to the characteristic of new product strategy, firms must adjust their value chain strategy relevantly. This paper can be used as starting point for further research to researchers and as strategic framework for new product development to practicians.

This paper has some limitations related with research context. Research framework is too narrow to properly represent general characteristics of value chain strategy and new product strategy. Definition of integrations and learning characteristic must be subtly supplemented. Other variables than market newness and product technology unfamiliarity must be incorporated as new product strategic elements. In modeling of proposed research context, equations used in our model can be criticized for their accuracy and validity. Further examination needs to be done for fining equations.

The results of this paper invoke us future research. Organizational learning is an important issue in organizational science area. More detailed investigation between fast-adaptive learning and slow-adaptive learning is an important future research topic. Another important future research topic is investigating the relationships among three types of integration in detail. Figure 3 implies that there may exist a efficient frontier of integrations. We can verify existence of the efficient frontier by further examination of our simulation model.

REFERENCES

[1] Barczak, G. 1994. Gaining superior performance of new products in the telecommunications industry. *Journal of Business and Industrial Marketing* 9 (4): 19-32.

[2] Bartlett, C. A. 1986. Building and managing the transnational: the new organizational challenge. In Competition in Global Industries, ed. M. E. Porter, 367-401. Boston, MA: Harvard Business School Press.

[3] Bowersox, D. J. and P. J. Daugherty. 1987. Emerging patterns of logistical organization. *Journal of Business Logistics* 8 (1): 46-60.

[4] Clark, K. B. and S. C. Wheelwright. 1993. *Managing new product and process development.* New York, NY: The Free Press.

[5] Cooper, R. G. 1985. Industrial firms' new product strategies. *Journal of Business Research* 13: 107-121.

[6] Cooper, R. G. and E. J. Kleinschmidt. 1987. New products: what separates the winners and losers?" *Journal of Product Innovation Management* 4: 169-184.

[7] Cooper, R. G. and E. J. Kleinschmidt. 1995. New product performance: keys to success, profitability and cycle time reduction. *Journal of Marketing Management* 11: 315-337.

[8] Craig, A. and S. Hart. 1992. Where to now in new product development research? *European Journal of Marketing* 26 (11): 1-49.

[9] Crawford, C. M. 1984. Protocol: new tool for product innovation. *Journal of Product Innovation Management* 2: 85-91.

[10] Donnellon, A. 1993. Cross-functional teams in product development: accommodating the structure to the process. *Journal of Product Innovation Management* 10: 377-392.

[11] Fisher, M. L. 1997. What is the right supply chain for your product? *Harvard Business Review* 75 (March-April): 105-116.

[12] Glazer, A. 1985. The advantage of being first. *American Economic Review* 75: 473-480.

[13] Greis, N. P. and J. D. Kasarda. 1997. Enterprise logistics in the information age. *California Management Review* 39 (3): 55-78.

[14] Griffin, A. 1997. The effect of project and process characteristics on product development cycle time. *Journal of Marketing Research* 34: 24-35.

[15] Harmsen, H., K. G. Grunert, and K. Bove. 2000. Company competencies as a network: the role of product development. *Journal of Product Innovation Management* 17: 194-207.

[16] Iansiti, M. 1995. Technology development and integration – An empirical study of the interaction between applied science and product development. *IEEE Transactions on Engineering Management* 42 (Aug.): 259-269.

[17] Jarillo, J. C. and J. I. Martinez. 1990. Different roles for subsidiaries: the case of multinational corporations in Spain. *Strategic Management Journal* 11:501-512.

[18] Kumar, K. and H. G. van Dissel. 1996. Sustainable collaboration: managing conflict and cooperation in interorganizational systems. *MIS Quarterly* 20 (3): 279-300.

[19] Mahajan, V. E. and J. Wind. 1992. New product models – practice, shortcomings and desired improvements. *Journal of Product Innovation Management* 9: 128-139.

[20] McGinnis, M. A. and J. W. Kohn. 1990. A factor analysis study of logistics *strategy. Journal of Business Logistics* 11 (2): 41-63.
[21] Morash, E. A. and S. R. Clinton. 1998. Supply chain integration: customer value through collaborative closeness versus operational excellence. *Journal of Marketing* 9 (4): 104-120.
[22] Ragatz, G. L., R. B. Handfield and T. V. Scannell. 1997. Success factors for integrating suppliers into new product development. *Journal of Product Innovation Management* 14: 190-202.
[23] Samli, A. C., J. M. Browning, and C. Busbia. 1998. The status of global sourcing as a critical tool of strategic planning: opportunistic versus strategic dichotomy. *Journal of Business Research* 43 (3): 177-187.
[24] Shapiro, B., V. K. Rangan, and J. J. Sviokla. 1992. Staple yourself to an order. *Harvard Business Review* 70 (4): 113-122.
[25] Shepherd, C. and P. K. Ahmed. 2000. NPD frameworks: a holistic examination. *European Journal of Innovation Management* 3 (3): 160-173.
[26] Sonnenberg, F. K. 1992. Partnering: entering the age of cooperation. *Journal of Business Strategy* 13 (3): 49-52.
[27] Tatikonda, M. V. and S. R. Rosenthal. 2000. Successful execution of product development projects: balancing firmness and flexibility in the innovation process. *Journal of Operations Management* 18: 401-425.

AUTHOR BIOGRAPHIES

HEUNGSHIK OH is a Doctoral Candidate in Graduate School of Management, KAIST. He received his B.S. in Industrial Engineering from KAIST, M.S. in Graduate School of Management, KAIST. His research interests include new product development, logistics management, system dynamics simulation. His email address is nofate@kgsm.kaist.ac.kr.

BOWON KIM is an Associate Professor in Graduate School of Management, KAIST. He received his B.B.A. from Seoul National University, M.S. from Stanford University, D.B.A. from Harvard University. He is a member of INFORMS, KORMS, and KSS. His interests include manufacturing learning theory, logistics management, optimal control theory, system dynamics simulation, e-business. His email and web addresses are bwkim@kgsm.kaist.ac.kr and <http://kgsmweb.kaist.ac.kr/people/faculty/bwkim.htm>.