Journal of Business & Management
Volume 3, Issue 4 (2014), 17-27
ISSN 2291-1995 E-ISSN 2291-2002
Published by Science and Education Centre of North America

Product Architecture and Supply Chain Management Design in Emerging Markets: A Case Study of Japanese Firms in Brazil

Youngwon Park[1*]

[1]Manufacturing Management Research Center, Graduate School of Economics, The University of Tokyo, Japan

*Correspondence: Manufacturing Management Research Center, Graduate School of Economics, The University of Tokyo, Japan, Kojima Hall 5F, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Tel: 81-80-4717-6632; E-mail: ywparkjp@gmail.com.

DOI: 10.12735/jbm.v3i4p17 URL: http://dx.doi.org/10.12735/jbm.v3i4p17

Abstract

No firm can control all areas of their supply chain. Product architecture is a crucial element of value analysis in supply chain management (SCM). In this article, we explore the following research questions: (1) What is the relationship between product architecture and SCM practices? (2) How can we apply this framework to business practices? To analyze our research topics, we will show a framework for relationship of product architecture and sourcing. To make our specific framework applicable to firms, we do case studies of Japanese firms in Brazil, comparing with Korean electronic firms in Brazil.

This paper mainly examines the case of Japanese firms in Brazil from the standpoint of product architecture and SCM. With a relatively weak Brazilian domestic supplier network, not all component parts can be deployed there. Global supply chain management is useful for cost reduction for certain raw materials. Technologically, some parts need to be procured from outside of Japan. In particular, many component parts for motorcycle manufacturers require integral architecture in contrast to electronics products. Firm H is successful in SCM integration through helping Japanese suppliers relating to integral architecture to move into Brazil and at the same time raising the internal production ratio. Lessons and implications are briefly discussed.

JEL Classifications: F14, F21

Keywords: product architecture, supply chain management design, integral architecture, emerging markets, Japanese firms

1. Introducation

Emerging markets in Brazil, Russia, India and China (BRICs) provide enormous opportunities and daunting challenges for global firms in the implementation of global supply chain management (Hong, Noh, & Hwang, 2006; Strutton, 2009; Chen & Nudelman, 2008; Anders & Usachev, 2003; Ovanessoff & Purdy, 2011). The Brazilian market in particular requires firms to adopt strategic approach with innovative products and services that fit Brazilian market environment and unique customer requirements (Gouvea, 2004; Gouvea & Kassicieh, 2012).

No firm may control all areas of its supply chain alone. One critical element of value analysis in SCM is to apply product architecture as a means of organizing systematic innovation in the contexts

of global supply chain management. Product architecture is the basic design philosophy which governs how products are divided in terms of product functions, structural component parts, and component interfaces through design processes. By design concept of product architecture firms may link core components and a product together throughout its value chain. Thus, product architecture makes an influence on the details of the make-or-buy decision (also called the outsourcing decision).

Products with modular architecture have a one to one relationship between functions and component modules so that each component is easily divisible (Fujimoto, 2003; Park & Hong, 2012; Park, Fujimoto, & Hong, 2012a). On the other hand, products with integral architecture show that functions and component parts are integrated as an indivisible unit. Modularity is the design process of dividing a complex system into divisible subsystems. The main characteristics of modular architecture are: (1) the division of complex systems by modules, (2) continuous evolution of the connection rules of modules, (3) the independent nature of each model from one another.

In this paper, we explore the following research questions: (1) What is the relationship between product architecture and SCM practices? (2) How can we apply this framework to business practices? For this research questions, we do literature review and show a specific framework applicable to firms. Fine regards strategic decision making as a critical issue for integration and specialization linkage of product-process-supply chain (Fine & Whitney, 1996; Fine, 1998; Fine, Vardan, Pethick, & El-Hout, 2002). Christensen, Verlinden, and Westerman (2002) also suggest a firm's appropriate decision making when a firm chooses to be vertically integrated or horizontally specialized according to the changes in product architecture. We will show a framework for the relationship of product architecture and sourcing to analyze our research topics. To make our specific framework applicable to firms, we do case studies for Japanese firms in Brazil.

2. Research Model

Product architecture is closely related to organizational structure (Park & Hong, 2012). Baldwin and Clark (2000) argue that it is necessary to maintain the consistency between product design and organizational design because product component architecture impacts the firm's organizational structure.

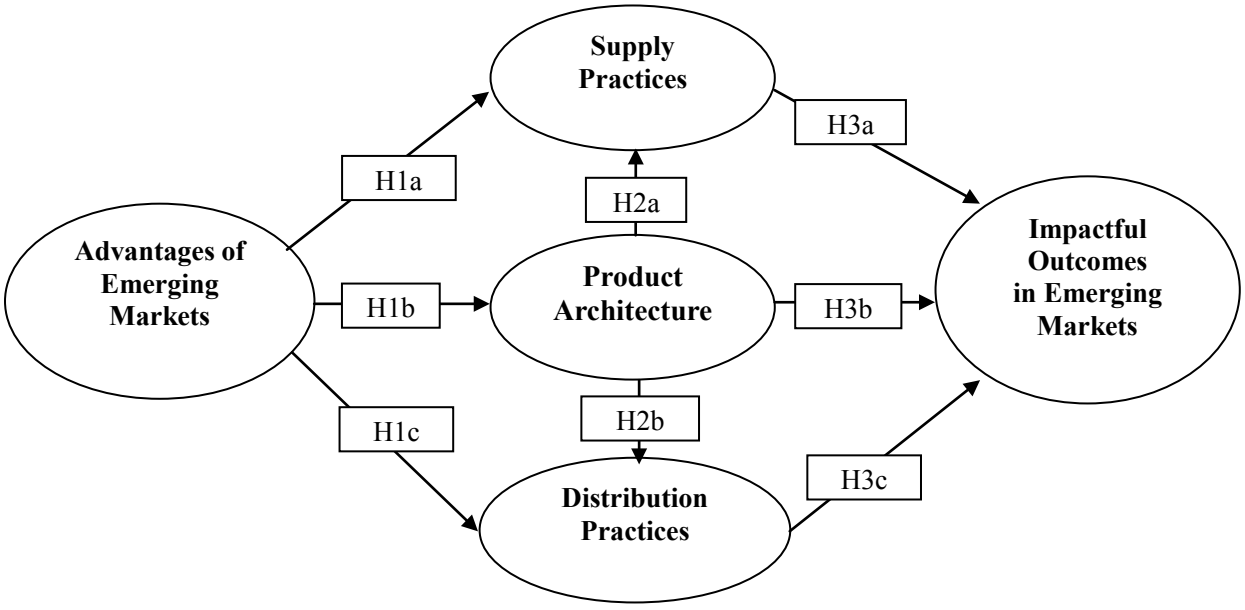

Figure 1. Product Architecture as a linking mechanism for emerging market strategy

If product component architecture is integral, then organizational architecture should be quite interdependent. On the other hand, modular product architecture requires organizational units to be divided according to specialized functions. Christensen *et al*. (2002) suggest that in view of product architecture, firms need to determine their organizational structure as either vertically integrated or horizontally specialized. Figure 1 shows the central theme of this paper that product architecture is an effective linking mechanism which brings market advantages into impactful outcomes of emerging markets through utilizing supply and distribution practices (Christensen, 1997; Christensen, 2002; Christensen *et al*., 2002; Shibata, Yano, & Kodama, 2005; Yassine & Wissmann, 2007; Park *et al*., 2012a). In this paper, impactful outcomes in emerging markets are defined as market advantage in terms of brand image, sales volume and market share. For the purpose of this paper, Figure 1 is briefly discussed in the form of hypothesis along with relevant literature review.

2.1 Challenges and Opportunities of Emerging Markets

Emerging markets provide both opportunities and challenges. Emerging markets provide low cost production options with huge domestic market sales potential (Hong *et al*., 2006; Strutton, 2009; Ovanessoff & Purdy, 2011). However, the practical challenges include high labor turnover/cost of training, weak supplier base, tax restrictions, different customer requirements, and logistics costs (Chen & Nudelman, 2008; Sakchutchawan, Hong, Callaway, & Kunnathur, 2011; Hong & Vonderembse, 2011; Park, Hong, & Moon, 2012b). Even so, global firms enter the emerging markets because the benefits of reaping opportunities are much greater than costs associated with these challenges. Thus, we define the advantages of emerging markets as the difference between benefits and cost of emerging market challenges. There must be a substantial difference between the potential benefits of emerging market opportunities and costs of emerging market challenges. In particular, through global network capabilities, this advantage motivates firms to channel their resources into the emerging markets (Hong *et al*., 2006; Anders & Usachev, 2003; Brouthers & Xu, 2002; Park & Hong, 2012). For the purpose of this paper, we define supply practices as the firm's efforts and processes of building and utilizing supplier base to take advantage of emerging markets (Chen & Nudelman, 2008). In addition, we also define distribution practices as the firms' efforts and processes of managing customer segmentations and marketing channel determinations to deliver their products and services to ultimate customers (Strutton, 2009; Park & Hong, 2012)

Thus, we hypothesize,

H1a. Advantages of emerging markets encourage firms to reconfigure their supply practices (i.e., building and utilizing supplier base to take advantage of emerging markets).

H1b. Advantages of emerging markets encourage firms to consider product architecture for providing products and services that fit the emerging market investment decisions (i.e., determining the nature of product overall structures and scope of product lines offerings).

H1c. Advantages of emerging markets encourage firms to configure distribution practices (i.e., customer segmentations and marketing channel determinations to deliver products and services to ultimate customers).

2.2 Product Architecture, Supply and Distribution Practices

A crucial element of value analysis in SCM is product architecture (Park & Hong, 2012). No firm is able to control all areas of their supply chain. Product architecture is the basic design philosophy which governs how products are divided in terms of component parts, product functions, and component interfaces through design processes. By product architecture, firms may link core components of a product together throughout its value chain and determine the details of the make-or-buy decision (Fine, 1998). SCM strategy based on make-buy decisions is an important

aspect of most firms' overall strategic plans (Tushman & Anderson, 1986; Gertner & Knez, 2000; McIvor & Humphreys, 2000; Perrons, Richards, & Platts, 2004; Perrons, Richards, & Platts, 2005).

Two major classifications of product architecture are modular and integral architecture (Fujimoto, 2003; Park & Hong, 2012; Park *et al*., 2012a). Products are located on the opposite ends of a continuum between modular and integral architecture. Even within the same family of products, different architecture may be applied according to diverse product positions and process structures. Japanese automobiles are a representative example of integral architecture. Designers of each module are responsible for the detailed requirements. They also need to collaborate closely for the integration of the overall product. On the other hand, products with modular architecture are organized by divisible elements of complex products and processes. Explicit design rules are applied to the process of dividing the complex system into semi-independent subsystems based on certain interface rules.

Modularity is the process of dividing a complex system into divisible subsystems. It is worthy to note several merits of modular product design (Feitzinger & Lee, 1997; Park & Hong, 2012). First, a firm may determine the numbers of basic components according to the needs for the final product. Any component may be added during the assembly process as an option. The product differentiation can occur by postponement (i.e., adding other components in the later stage). Second, a firm may be flexible in attaining any particular modules. Any modules can be configured according to the specific process goals (e.g., reduction of the total production time). Third, product problems are more easily recognizable because the specific cause of ambiguous product quality issues can be more quickly identified. Modularity is also regarded as a key for logistics cost reduction, lead-time improvement, and customization (van Hoek & Weken, 1998; Park & Hong, 2012). Since modularity usually involves the standardization of component parts and product groups, it facilitates an internal integration of functions within firms. Modularity considers both horizontal and vertical component requirements that include the expectations of the entire supply chain (e.g., procurement and logistics elements). In sum, by applying modular architecture, firms may simplify operation processes and accordingly achieve drastic cost reductions. In this way, the global supply chain is enhanced. However, products with modular architecture may lose competitive advantage, as it is comparatively easy for rivals to imitate products with modular architecture. In terms of sustainable competitive advantage, firms have to consider two aspects of product architecture simulataneously. Thus, product architecture is regarded as an essential analytical tool that examines how firms create value through complex business processes in the global supply chain.

Thus, we hypothesize,

H2a. The classification of product architecture type (e.g., modular or integral) impacts the supply practices of firms (i.e., building and utilizing supplier base to fit overall product and service strategy).

H2b. The classification of product architecture type (e.g., modular and integral) impacts the distribution practices of firms (i.e., customer segmentations and marketing channel determinations to deliver products and services to ultimate customers).

2.3 Product Architecture, Supply and Distribution Practices and Outcomes

With increasing product complexity, networking gains significance because no single firm can handle all of the unpredictable market requirements. Likewise, it is inconceivable for any firm to develop and produce all of the components of a product. It is unreasonable to vertically integrate all of the upstream and downstream of supply chain. Fine (1998) regards strategic decision making as critical for integration and specialization linkage of product-process-supply chain. Christensen *et al*. (2002) also suggest appropriate decision making whether a firm's network chooses to be vertically integrated or horizontally specialized according to the changes in product architecture. Vertically

integrated networked firm performs better in a market where customer requirements for product quality and functionality are not yet met. On the other hand, horizontally specialized networked firm performs well in a market with little demand for functionality. Vertically integrated firms occupy leadership position in the underdeveloped market. Yet, vertical integration is not so effective in a context where technological progress exceeds customer needs. However, in a new market where there is a noticeable gap between customer desired quality and product functionality, vertically integrated firms find room for growth. As a dominant business model in a market moves from vertical integration to horizontal specialization, producers of the finished products may not generate much profit. Rather, sub-component parts suppliers take a large share of yield. Christensen *et al*. (2002) observe that component suppliers usually make more profit in commodity products which have satisfied all known customer needs.

After 1990s, as the concept of strategic outsourcing and strategic alignment became popular, the strategic relationship between OEMs and their suppliers has become an important element of business success. Furthermore, SCM is extending beyond a firm's organizational boundaries toward attaining mutual benefits (Demeter, Gelei, & Jenei, 2006), which compels firms to concentrate on their unique and competitive business areas. Therefore, partners increasingly are ruminating on ways to contribute to their Supply Chains based on their core competences (Chiang & Trappey, 2007). Such efforts assist firms to strengthen their core competences and to build up cooperative relationship with other firms to strengthen necessary areas. Table 1 shows our conceptual framework based on Fine (1998) and Christensen *et al*. (2002). This suggests that the type of product architecture (e.g., integral or modular) impact the extent of insourcing and outsourcing.

Table 1. Comparison of integral and modular architecture for sourcing arrangements

Product Architecture	Internal sourcing	Outsourcing
Integral	Insourcing is best	Outsourcing is worst or at least risky.
Modular	Cost problem in case of insourcing	Best Outsourcing opportunity

Accordingly, product architecture determines the level of insourcing and outsourcing of firms' product component parts to deliver goods and services to ultimate customers for the impactful outcomes in the emerging markets. As we mentioned, impactful outcomes in emerging markets are defined as market advantage in terms of brand image, sales volume and market share. We use the term impactful outcomes in that such outcomes are not static but dynamic and constantly changing in turbulent competitive environments of emerging markets (Park & Hong, 2012).

Thus, we hypothesize,

H3a. Supply practices of firms (i.e., building and utilizing supplier base to fit overall product and service strategy) influence the level of impactful outcomes in emerging markets (i.e., market advantage in terms of brand image, sales volume and market share).

H3b. The type of product architecture (e.g., modular and integral) influences the level of impactful outcomes in emerging markets (i.e., market advantage in terms of brand image, sales volume and market share).

H3c. Distribution practices of firms (i.e., customer segmentations and marketing channel determinations to deliver products and services to ultimate customers) influence the level of impactful outcomes in emerging markets (i.e., market advantage in terms of brand image, sales volume and market share).

3. Case Study Illustrations

This section focuses on the relationship between product architecture and SCM through the case studies of Japanese and Korean firms operating in Brazil. A deductive case study approach is used to evaluate a proposed framework to analyze relationship between product architecture and SCM. Case-based research is widely used in the field of operations management studies related to theory building (Eisenhardt, 1989; Voss, Tsikriktsis, & Frohlich, 2002; Holweg & Helo, 2014). For the purpose of this paper we collected qualitative data based on interviews with managers and also supporting quantitative secondary database to evaluate case firms' performance. To compare electronics firms and motorcycle manufacturers in the Manaus Region of Brazil, we visited the factories of case firms of Manaus region in Brazil in 2010-2011. The data collection for this paper included data collected from on-site at the factories of case firms in Manaus of Brazil and semi-structured interviews.

3.1 Electronic Firms in Brazil

The operational effectiveness of Japanese firms in Manaus Region, Brazil is relatively high. Labor turnover rate, for example, is low because cases of employees' voluntary resignation and departure are small in number. For the case of Firm B, monthly resignation rate is no more than 0.1% (Ooki, Shintaku, Park, & Amano, 2010). China, in contrast, has relatively high labor turnover rates. On the other hand, Japanese firms in Manaus Region, Brazil afford to maintain consistently stable level of operation. Furthermore, the skill level of workers is high as well. The characteristics of workers in Firm C are "dexterous in their hand skills". Many female workers in Firm C are ambidextrous (i.e., using both hands) in their operations of multiple tasks. Thus, Japanese firms in Manaus Region have achieved a high level of operational effectiveness (i.e. similar to that by multi-skilled workers in Japan) through stable employee retention, multi-skilled workers, and their dependability.

However, such operational effectiveness is not necessarily translated into the competitive advantage of these firms. In terms of operational effectiveness Japanese firms are comparable or better to that of Korean counterparts in Brazil. Korean firms in Brazil focus on overall product planning and supply chain strategy rather than developing multi-skilled workers. Korean firms hold the overall market leadership in Brazil. Korean firms excel in their responsive supply chain strategy through offering products and services that satisfy Brazilian customers. Japanese firms in China, ASEAN Region and India have been adapting their products and services to the local market requirements. In Brazil, these firms have not yet successfully developed the required level of local responsiveness. This is the strategic priority of Japanese firms in the future. Because of their inadequate supply chain responsiveness, logistics lead times of Japanese firms are still several months. When we compare Japanese to Korean firms, Japanese firms are substantially behind Korean firms in terms of logistics lead times. As we suggested Hypotheses 1-3, in case of products with modular architecture type, outsourcing decision making is critical for best performance. For this, effective supply chain management is imperative. Currently, Japanese electronic firms are inferior to Korean electronic firms in terms of effective supply chain responsiveness and thus their performance is less than Korean firms.

3.2 Motorcycle Manufacturers in Brazil

Competitive battles became intense after the Brazilian government restricted the total number of motorcycles that could be imported in 1974 (Seo, Shintaku, Park, Lee, & Ooki, 2012). In response to this policy change, many multi-national corporations (MNCs) started their production in Brazil. Firm Y built its manufacturing plant in Sao Paulo in 1974 and Firm H did the same at Manaus. At that time, the total market demand was no more than 50,000 units. By 1982 the total production volumes grew to be 220,000. With economic recession in Brazil, the overall market size and the production volume has decreased. From 1993, the motorcycle market showed signs of recovery and

accordingly, production volume steadily increased. In 1993, the total production was 100,000 units and by 2002 it grew to 900,000 units. Recently, Brazilian motorcycle market is dominated by Japanese firms. The market share in 2009 was 75.4% by Firm H and 12.2% by Firm Y and 5.3% by Firm S; thus the total market share of Japanese firms has been over 90%.

In 1976, Firm H started its operations in Manaus to take advantage of the tax incentives. Its initial production of 125 CC model was a small scale with 276 employees. The plant was located in the outskirts of Manaus—20 km away from the airport and close to Amazon River. By 2010, the total accumulated production was 14,830,000 units. At Manaus plant, Firm H produces for both domestic customers and export purpose for global markets. Out of the Total 28 product models, 19 product models are produced for both domestic and export purpose, and 10 models are solely for export. Major export destinations include 70 countries in North America, Latin America, and Africa.

The critical challenge in Manaus plant is logistics. Manaus is located along the middle section of the Amazon River that flows through Brazil. Very few suppliers are in Manaus. Most uppliers are in the vicinity of Sao Paulo. Transportation from Sao Paulo to Manaus requires five days from Sao Paulo to Beren, and another five to six days from Beren to Manaus by ship. The total transportation takes at least ten days.

Since Brazil is far away from Asia, it takes more than 30 days to get from Japan to Manaus. Components from other Asian regions such as China require at least 45 to 50 days of transportation time. Such logistics constraints are a huge challenge for Firm H's operations in Manaus. Reflecting logistics challenge, Firm H's Manaus plant naturally maintains high insourcing rate (i.e., the rate of internal production of component parts). Firm H achieves high market share primarily because of its early and heavy investment strategy within the Brazilian market. Compared to Firm Y, Firm H entered Brazilian Market 10 years earlier and its investment continued even during Japan's recession periods in the 1990s. Marketing strategy of Firm H does not limit particular product models. It offers a broad range of product models including Cave, Scooter, CG, KL, and LS (i.e., large size). The most popular product line is 100-120 cc class products in CG line. Even so, Firm H pursues mass customization marketing strategy.

In the early 2000, many Japanese firms withdrew from Manaus. In 2000, Sanyo stopped the production of TV, VTR, and Electronics Range. In 2001 Murata stopped its ceramic filter production, and on the same year Seiko and in 2002, Fujitsu discontinued all of its product lines. In such business climate, Firm H maintained its production in Manaus because this special economic region allows tax incentives to firms. The stipulations for tax benefits require manufacturing and assembly in Manaus. For example, as a part of clutch manufacturing (i.e., Firm H's core component parts), aluminum die cast and its assembly must be done in Brazil. In view of long transportation time from Japan and specific legal requirement, Firm H accepts such manufacturing and assembly restrictions. The production plan period naturally extends to one year for its suppliers in Japan. In spite of tax advantages, Firm H needs to devise better SCM that overcomes the specific logistics challenges in Manaus. For this, Firm H invited core suppliers to Manaus. As a result, Firm H could achieve the internal production ratio including procurement of core suppliers which moved into Manaus from Japan and also keep high quality for production of integral architecture product.

3.3 Comparison of Case Firms

As we discussed, product architecture impacts and determines the level of insourcing and outsourcing of firms' product component parts to deliver goods and services to ultimate customers for the impactful outcomes in the emerging markets. When we compare Japanese electronic firms and motorcycle firms in Manaus region of Brazil, Firm H, one of motorcycle firms attained good outcomes in Brazil markets in terms of brand image, sales volume and market share. However, when we compare Japanese to Korean electronic firms, performance of Japanese electronic firms is not so good, even though their operational effectiveness is high. These results show that our

Hypotheses 1-3 can be acceptable as shown in table 2. By exploratory case studies, we hence propose that the type of product architecture influences the level of impactful outcomes in emerging markets.

Table 2. Comparison of case firms

Product Architecture	Internal sourcing	Outsourcing
Integral	Motorcycle firms (e.g. Firm H)	
Modular		Japanese electronic firms (It is necessary to develop adequate supply chain responsiveness)

4. Conclusion and Discussion

This paper mainly examined the practices of Japanese firms in Brazil with specific focus on product architecture and SCM, comparing to Korean firms. Brazil is quite far away from Japan. SCM integration therefore requires overcoming logistical challenges. With a relatively weak supplier base in Brazil, not all component parts are deployed in Brazil.

Global supply chain management is useful for cost reduction. Technologically, some parts need to be procured from outside of Japan. In particular, component parts for motorcycle manufacturers require integral architecture in contrast to electronics products. It is quite expensive to transport component parts from Japan to Brazil. For example, in March 11, 2011, there was a severe earthquake in the eastern part of Japan. Japanese firms in Brazil experienced its impact only in May. The component parts that were shipped before March 11 arrived in May, 2011. In contrast to other Japanese firms that abandoned their production in Manaus early, Firm H is successful in SCM integration through helping Japanese suppliers to move into Brazil and at the same time raising the internal production ratio.

The case illustrations are based on in depth interviews of senior management of Japanese firms in Brazil and actual visiting of the plant sites in 2000 and 2011. The findings of these case illustrations suggest that Korean firms maintain a strategic advantage in the Brazilian market through their modular architecture for electronics products with effective supply chain management strategy including bold investment decisions and effective supply and distribution practices. In contrast, Japanese firms maintain market advantage in motorcycle products that adopt integral product architecture. These Japanese firms also show that product integrality increases in development capabilities in that Japanese motorcycle manufacturers take advantage of integral architecture to set higher barriers of entry against their competitors and at the same time increase the volume requirements in the growing market (Ülkü & Schmidt, 2011). In case of huge logistics challenges, the advantage of modular architecture is not necessarily realized through outsourcing in the emerging markets—particularly in Brazil. Thus, firms need to strategically configure product architecture along with supply chain management that includes both supply and distribution practices for impactful outcomes in emerging markets.

Finally, we suggest management implications in emerging markets. Korean electronic firms targeted the emerging economies in 1990s and established strong business presence in emerging markets such as BRICs and deployed their financial, marketing and production resources for rapid expansion and growth. In particular, they constructed responsive supply chain management using IT system. However, Japanese firms were more cautious about policy changes of Brazilian government and thus remain passive for more than twenty years in realizing these market potentials (Ooki *et al*., 2010). Brazilian government's numerous policy changes since 1970s have dictated these global

firms to revise and refine their business models. To Japanese firms these emerging markets were almost forgotten. By 2000s the market growth rates in Brazil were too obvious and yet Japanese firms could not afford to make large investment with lack of resource support from their headquarters in Japan. On the other hand, Korean firms have made aggressive investment on Brazil immediately after they overcame Asian Financial Crisis in 1990s. Investment timing and amount depend on political conditions and economic policy changes. Yet, timely and bold investment in these emerging economies is quite crucial for their global strategy success. In this sense, Korean global firms have made serious policy adjustments and organizational system building efforts in response to these rapid environmental changes. Their bold decision making styles for tapping the growth potential of these emerging markets are instrumental for their successful market performance. It is worthy to observe and study further how these Korean firms supply chain management as an essential aspect of their global market strategy. Their global supply chain management certainly provides rich theoretical and managerial implications and thus deserves further research attention in that it is quite different from global supply chain strategy of large firms from USA and European Union as well as Japan.

Acknowledgements

This article was supported by Japan Society for the Promotion of Science (JSPS) KAKENHI (Grant-in-Aid for Scientific Research (C) 24530493) and the Graduate Program for Social ICT Global Creative Leaders (GCL) at the University of Tokyo.

References

[1] Anders, G. C., & Usachev, D. A. (2003). Strategic elements of Eastman Kodak's successful market entry in Russia. *Thunderbird International Business Review, 45*(2), 171 – 183.

[2] Baldwin, C. Y., & Clark, K. B. (2000). *Design rules: The power of modularity*. Cambridge, MA: MIT Press.

[3] Brouthers, L. E., & Xu, K. (2002). Product stereotypes, strategy and performance satisfaction: The case of Chinese exporters. *Journal of International Business Studies, 33*(4), 657-677.

[4] Chen, M., & Nudelman, R. (2008). Negotiating a supply contract in China — Case comment: Negotiating a supply contract in China. *Thunderbird International Business Review, 50*(4), 271-281.

[5] Chiang, T-A., & Trappey, A. J. C. (2007). Development of value chain collaborative model for product lifecycle management and its LCD industry adoption. *International Journal of Production Economics, 109*(1-2), 90-104.

[6] Christensen, C. M. (1997). *The innovator's dilemma: When new technologies cause great firms to fail*. Boston, Massachusetts: Harvard Business Press.

[7] Christensen, C. M. (2002). The rules of innovation. *Technology Review, 105* (June), 33-38.

[8] Christensen, C. M., Verlinden, M., & Westerman, G. (2002). Disruption, disintegration and the dissipation of differentiability. *Industrial and Corporate Change, 11*(5), 955-993.

[9] Demeter, K., Gelei, A., & Jenei, I. (2006). The effect of strategy on supply chain configuration and management practices on the basis of two supply chains in the Hungarian automotive industry. *International Journal of Production Economics, 104*(2), 555-570.

[10] Eisenhardt, K.M. (1989). Building theories from case study research. *The Academy of Management Review, 14*(4), 532-550.

[11] Feitzinger, E., & Lee, H. L. (1997). Mass customization at Hewlett-Packard: The power of postponement. *Harvard Business Review, 75*(1), 116-123.

[12] Fine, C. H., (1998). *Clockspeed: Winning industry control in the age of temporary advantage*. Reading, Massachusetts: Perseus Books.

[13] Fine, C. H., Vardan, R., Pethick, R., & El-Hout, J. (2002). Rapid-response capability in value-chain design. *Sloan Management Review, 43*(2), 69-75.

[14] Fine, C. H., & Whitney, D. E. (1996). Is the make-buy decision process a core competence? *MIT Sloan School of Management Working Papers Series with number #140-96*; *Working Paper (Sloan School of Management), No. 3875-96*.

[15] Fujimoto, T. (2003). *Noryoku kochiku kyoso (Capability-building competition), Chukousinsyo* (in Japanese). *English translation: Competing to be really good* (B. Miller, Trans.). Tokyo: International House of Japan, Tokyo.

[16] Gertner, R., & Knez, M. J. (2000). Vertical integration: Make or buy decisions. In T. Dickson (Ed.), *Mastering strategy* (pp.146-151). Harlow, UK.: Pearson Education Limited.

[17] Gouvea, R., & Kassicieh, S. (2012). Bridging the innovation divide: The Brazilian experience. *Thunderbird International Business Review, 54*(3), 275-289.

[18] Gouvea, R. (2004). Doing business in Brazil: A strategic approach. *Thunderbird International Business Review, 46*(2), 165-189.

[19] Holweg, M., & Helo, P. (2014). Defining value chain architectures: Linking strategic value creation to operational supply chain design. *International Journal of Production Economics, 147*(B), 230-238.

[20] Hong, P., Noh, J., & Hwang, W. (2006). Global supply chain strategy: A Chinese market perspective. *Journal of Enterprise Information Management, 19*(3), 320-333.

[21] Hong, P., & Vonderembse, M. (2011). Global logistics strategies and experiences: The case of Korea Express. *International Journal of Logistics Systems and Management, 9*(2), 141-149.

[22] McIvor, R. T., & Humphreys, P. K. (2000). A Case-based Reasoning Approach to the Make or Buy Decision. *Integrated Manufacturing Systems, 11*(5), 295-310.

[23] Ooki, K., Shintaku, J., Park, Y. W., & Amano, T. (2010). Monozukuri of Brazil Amazon: History of Manaus: Industrial City and Challenges of Japanese Firms. *Akamon Management Review, 9*(11), 825-848 (In Japanese).

[24] Ovanessoff, A., & Purdy, M. (2011). Global competition 2021: Key capabilities for emerging opportunities. *Strategy & Leadership, 39*(5), 46-55.

[25] Park, Y., Fujimoto, T., & Hong, P. (2012a). Product architecture, organizational capabilities and IT integration for competitive advantage. *International Journal of Information Management, 32*(5), 479–488.

[26] Park, Y., Hong, P., & Moon, G. (2012b). Implementation of product strategy with differentiated standards. *International Journal of Technology Management, 57*(1/2/3), 166-184.

[27] Park, Y. W., & Hong, P. (2012). *Building network capabilities in turbulent competitive environments: Practices of global firms from Korea and Japan*. Boca Raton, FL: CRC Press (Taylor & Francis Company).

[28] Perrons, R. K., Richards, M. G., & Platts, K. (2004). The Effect of Industry Clockspeed on Make-Buy Decisions in the Face of Radical Technologies: An Empirical Test. *International Journal of Innovation Management, 8*(4), 431-454.

[29] Perrons, R. K., Richards, M. G., & Platts, K. (2005). What the hare can teach the tortoise about make-buy strategies for radical innovations? *Management Decision, 43*(5), 670-690.

[30] Sakchutchawan, S., Hong, P. C., Callaway, S. K., & Kunnathur, A. (2011). Innovation and Competitive Advantage: Model and Implementation for Global Logistics. *International Business Research, 4*(3), 10-21.

[31] Seo, Y., Shintaku, J., Park, Y. W., Lee, T., & Ooki, K. (2012). Success and challenges of Japanese firms through the automobile and motorcycle in Brazil. *Akamon Management Review, 11*(8), 405-424 (In Japanese).

[32] Shibata, T., Yano, M., & Kodama, F. (2005). Empirical analysis of evolution of product architecture: Fanuc numerical controllers from 1962 to 1997. *Research Policy, 34*(1), 13-31.

[33] Strutton, D. (2009). Horseshoes, global supply chains, and an emerging Chinese threat: Creating remedies one idea at a time. *Business Horizons, 52*(1), 31-43.

[34] Tushman, M. L., & Anderson, P. (1986). Technological Discontinuities and Organizational Environments. *Administrative Science Quarterly, 31*(3), 439-465.

[35] Ülkü, S., & Schmidt, G. M. (2011). Matching Product Architecture and Supply Chain Configuration. *Production and Operations Management, 20*(1), 16-31.

[36] van Hoek, R. I., & Weken, H. A. M. (1998). The impact of modular production on the dynamics of supply chains. *The International Journal of Logistics Management, 9*(2), 35-50.

[37] Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations and Production Management, 22*(2), 195-219.

[38] Yassine, A. A., & Wissmann, L. A. (2007). The Implications of Product Architecture on the Firm. *Systems Engineering, 10*(2), 118-137.

Copyrights