A Conceptual Framework for Product-Process Matrix: A Supply Chain Perspective

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Abstract: The paper integrates insights from previous research on operation management and supply chain management into generalization and extension of the product-process matrix. We propose a conceptual model on product-process matrix from a supply chain perspective, and to discuss the impact of collaboration with supply chain partners on product-process matrix. From an operational viewpoint, the model proposes that process (included new product development, production and delivery) flexibility should be aligned with the level of product customization. Meanwhile, from a collaborative strategy viewpoint, this model indicates that collaboration with supply chain partners exert a positive impact on matching of process and product on operational level. At last, a single case study by conducting in-depth surveys and interviews in one company is employed to verify and adjust the conceptual mode.

Keywords: conceptual mode, case study, product-process matrix, supply chain management

1 Introduction

Over the years, the market environments are changing in dramatic ways—for customers, demand for product customization is swelling; for firms, supply chain collaboration as a key source of competitive advantages is flourishing\(^1\). Intensive competition in the market place has forced companies to respond more quickly to requirements through faster product development, more flexible production process and shorter delivery time\(^2\). One fundamental challenge for operations managers is to design proper processes that satisfy the customization requirements in the supply chain environment\(^3\). For the past three decades, practitioners could obtain guidance from the product-process matrix (PPMX) of Hayes and Wheelwright\(^4\). They emphasized that that small batch and various variety product mix should be accordance with the high flexible production process such as job shop, whereas the high volume and commodity product mix needs low-cost and standardization production process such as assembly line. Many researchers has been updating the model for the purpose of matching the rapidly changing market environment, including extending from the product dimension to service dimension, introducing this dynamic environment as a third dimension, discussing the influences of initiatives (flexible technology, modular design, managerial innovation, etc.)\(^5\). However, previous studies mostly followed fixed research paradigm: firstly, the object of research focused on the matching the internal process of firms and product from an operational perspective, whereas ignoring the impact of external process from supply chain partners, especially strategic collaboration; secondly, the process dimension are defined as production process, but other processes(such as: product development, delivery process) which are equally related to product dimension have been disregarded.

This paper intends to contribute to filling this gap by structuring the PPMX model from a supply chain perspective. The aim of this model to answer the following questions:

RQ1: From an operation perspective, how should the model be updated to take into account the customization requirements?

RQ2: From a supply chain perspective, how should the current product-process matrix model be revised to take into account the collaboration strategy with supply chain partners?

RQ3: Nowadays, why can some excellent firms achieve the best operational performance when their internal processes structure fail to match with the product characteristic?

2 Literature reviews on PPMX

The traditional product-process matrix (PPMX) proposed by Hayes and Wheelwright\(^6\) links different production processes to the different product life cycle stages, and focuses on goods manufacturing operations (see Fig. 1). This two-dimensional model represents a direct relationship between product structure and process structure. The underlying logic of this matrix is that a product would need different types of process in different stages of the product life cycle. As the product matures and the sales volume increases, there is a need to shift from the initial low-volume/high- flexibility stage to a high-volume/low-cost manufacturing process. On the
base of Skinner's trade-off theory, Hayes and Wheelwright developed the product-process matrix to emphasize the importance of cooperation between manufacturing (process) and marketing (product) to achieve the unified goals [6].

Nowadays the environment of firms are changing in dramatic ways, product life cycle is shorter, demand for product customization is swelling, and pressures for globalization and technological innovation are overwhelming [9]. Under this circumstances, firms must be able to meet what have traditionally been contradictory requirements: continuously delivering customized, high-quality goods and services while simultaneously keeping costs down and getting products to market quickly [10]. Although the PPMX is one of the most widely recognized concepts in the manufacturing strategy area, its adaptability is decreasing with the environment changes.

Up till now, the traditional PPMX has been frequently verified and commented upon by researchers. First, with the changes of environment, many researchers have discussed the simplicity of dimensions under the new contemporary industrial condition. Hill et al. applied the PPMX as well as product profiling to study the fit between product mix and process structure in one case company [5]. They concluded that it was difficult to explain the alignment between manufacturing orientation and the characteristics of the market by using the traditional PPMX. Bozarth and Berry argued that PPMX is based on assumptions about the characteristics of classic process choices which have significant limitations [11]. Given recent developments in manufacturing technologies and approaches, current research suggests that these assumption or identification of dimensions may not be valid, or at least should be critically reevaluated and enriched. Heikola and Tenhiala proposed a modification model based on contingency theory as the generalization and extension of the traditional matrix [7]. They extended the original process dimension into a specificity dimension which depended on the layout and flexibility of the process. Similarly, the product dimension was generalized to the complexity of the production task. Meanwhile, they extended the model to accommodate the dynamism of the task environment and added a third dimension—the dynamism of the production task. Most of these modifications have greatly enriched the dimensions and enhanced the match between product and process structure.

Second, there have also been some other studies focused on analyzing the influence of flexible process capability (FPC) on the validity of traditional PPMX. Particularly, in order to make up for the inability to account for the dynamic nature of firms’ operating environments, this kind of study was mainly resulted in numerous modifications and extensions on traditional PPMX. With advanced manufacturing technologies, Noori argued that the idea of coupled product-process life cycles is no longer valid because products can pass through their entire life cycle by using one single flexible facility [12]. In order to explain the validity of the off-diagonal area in traditional PPMX, Ariss and Zhang have discussed and empirically tested the impact of FPC on the PPMX and introduced a third dimension, innovative initiatives, which represents the proactiveness of an organization towards adopting, implementing and practicing innovative processing technology, product design, and managerial practice [13].

Third, discussing the multiple performances implication instead of trade-offs, the product-process matrix of Hayes and Wheelwright has been widely known for its prescriptive managerial guidance. Yet, most empirical studies have found no support for its performance assertions or have even contradicted them. With the dramatically changed environments, some authors have empirically verified that firms can achieve multiple competitive performances simultaneously [14-15]. Especially, a number of researchers have argued that the use of certain new management or technological
initiatives which usually refer to the flexibility can eliminate or at least minimize some of the trade-offs [16-17]. Nowadays, we often find that enterprises which deviated from the diagonal area will still be able to succeed. This phenomenon was well explained in the research of Ariss\textsuperscript{[13]}. And their study also provides further evidence of the compatibility of multiple competitive performances rather than trade-offs, by considering the influence of flexible process capability.

In summary, the explanations for the limited empirical support for the traditional PPMX fall into three main categories: simplicity of the dimensions, influence of FPC on the validity and performance implication of PPMX, and inability to account for the dynamic nature of firms’ operating environments. Therefore, on the base of previous research and considering nowadays supply chain competition environment, the traditional product-process matrix needs some further modifications; extending from individual firm’s manufacturing operations to supply chain strategy. Then, in the following sections, we will synthesize the findings of the earlier studies with the objective of amending the shortcomings of the original model; particularly, we will hold the perspective of supply chain management and take the core firms’ collaboration with upstream and downstream partners as the starting point to conduct modification.

3 Conceptual model

3.1 Customization as product dimension

In previous research on the product-process matrix, the market demands were linked with product structure which consists of the product volume and variety, and the product dimension was usually based on volume, ranging from high variety/low volume to low variety/high volume\textsuperscript{[5-6] [18]}. Nevertheless, today, product variety and volume fails to describe the multiple market needs, for example, product mass customization (MC) make it possible to produce varied and customized products at low cost with standardized and mass production system, being characterized by high variety/high volume\textsuperscript{[19]}. In addition, the coupling of volume and the degree of customization in the product-process matrix may not hold true for some manufacturing firms\textsuperscript{[20]}. In fact, customers nowadays require products to be almost individually tailored to their needs, desires, and personalized statements, then, it is a trend to connect market demands of product in term of customization.

Consequently, the product volume dimension of the original matrix should be extended to the degree of product customization. In order to represent how extensively the products are customized, Ahmad and Roger recognized that customized products could be divided to five categories: highly customized, somewhat customized, standard with custom options, somewhat standardized and highly standardized\textsuperscript{[21]}. Lampel and Mintzberg argued that customization was involved the entire product life cycle stages from the distribution, assembly, fabrication, to finally design\textsuperscript{[22]}. From the value chain perspective, product customization was classified to five types: pure standardization, segmented standardization, customized standardization, tailored customization and pure customization, as showed in figure2. Therefore, the customization is taken as product dimension instead of “product variety” or “product volume” in this research.

![Fig.2 A continuum of customization strategies (source: Lampel and Mintzbergy)](image)
3.2 Flexibility as process dimension

The process dimension of the original matrix focused on the layout of the production process, including four types: job shop, batch shop, assembly line and continuous [6]. The process evolution typically begins with a fluid process (highly flexible) and proceeds toward increasing standardization, mechanization, and automation (highly rigid). However, the process flexibility technologies have changed fundamentally and the production layout may not hold true, for example, the use of modular parts and flexible manufacture systems (FMS) has allowed some assembly/continuous flow shop to achieve customization in mass quantities, similarly, some batch shops apply similar methods to produce standardized product in moderate to high volumes. It is argued that flexible technologies have important implication for product process matrix framework. Leschke emphasized that firm could use flexible process technologies to enhance mix flexibility (product mix) when the varieties of product mix have changed and the production process was stabilized [23]. Thus, the model should be updated to accommodate the flexibility of modern process technologies [7].

In essence, the process flexible technologies increase the process flexibility, thus, the process choice should take the flexible capability into account rather than the layout. Ariss contended that high flexible process capability (FPC) which is the firm’s ability to customize the products enlarged the feasible zones and reduced the constrained zone in the product-process matrix [13]. As the result, Helkilo labeled “the specificity of production process” as the process dimension and defined it as the degree to which the process is limited to producing certain outputs. Hence, to follow the logic of original process evolution and to grasp the essential characteristics of flexible process technologies, the flexibility will be chose as process dimension [7]. Meanwhile, due to the customization happened from product design to distribution, a characterization of the dominant production process can fail to illustrate the process structure and process choice [18]. It is necessary to extend the process from single production process to multiple processes which impacts the customization, including new product development (product design), production (product fabrication and assembly), and delivery (product distribution). To simplify the process stages, the fabrication and assembly stages are combined as production process instead, for accommodating the change, the customized standardization also merges into the tailored customization in this paper, as showed in figure 3.

In summary, in this study, the process dimension is amended in term of two main aspects. For one thing, the process content is enriched from sole production process to new product development, production and delivery process. For another, the flexibility is introduced as process dimension rather than “process layout” or “process type”.

Fig.3 Linkages between the process structure and customization degree
3.3 Supply chain environment as an additional dimension

To develop a product-process matrix that better corresponds with the contemporary industrial reality, it is insufficient only to enhance its original dimensions. Kemppainen indicated that an important area of product-process matrix in the future research was an extension of tool into assessment of supply chain environment [18]. Moreover, with the efficient development of the global market economy, competition no longer take place between individual enterprises, but between entire supply chains[24]. That is to say, the supply chain partners will play an important role in the mapping of process and product. For example, as for the segmented standardization products, if enterprises could not provide an appropriate delivery process to meet the customized distribution, then it is a good choice for them to cooperate with logistics enterprises to make the fit of delivery process and segmented standardization of product (work this out). In other words, the process dimension can be transformed by collaboration with supply chain partners. In addition, from the strategic perspective, the strategy such as integration, cooperation, and collaboration plays an important role on the product and process dimension [25-26].

Therefore, there is a need for the supply chain environment to be incorporated into the matrix. In order to link closely the supply chain environment with the original two dimensions, the process dimension is enriched into two aspects, including internal process and external process, see figure 4. And internal process indicates the process of core firm in supply chain, on the contrary, the external process is the product process of other stakeholders (such as: suppliers, manufactures, distributors and customers) in supply chain.

3.4 Product-Process Matrix: a supply chain perspective

As mentioned previously, the existing literature give three main explanations for original product process matrix’s limitations. First, the product dimension (i.e., product volume and variety) is too narrow as a proxy to reflect the individual requests of customers. Similarly, the process dimension (i.e., process type) does not concern the effect of process flexible technologies. Secondly, scholars mostly focus on the match of product and single production process, whereas other processes which are equally related to product dimension have been ignored. Third, the original matrix disregards the vital impact of the supply chain strategy. In order to amend these limitations, a modified product process matrix (PPM) model is proposed, shown in figure 5.
In this model, the product and process characteristic are revised respectively as customization and flexibility. What is more, instead of focusing on the single production process, the process is extended from single production process to three kinds of processes, including NPD, production, and delivery process. Lastly, to link the supply chain strategy (such as: process integration or collaboration) with the matrix, the process dimension is enriched as internal process and external process. For these reasons, the feasible region of the PPM is a kind of irregular stereoscopic area which consists of two main cross-sectional zones. In line with previous studies on PPM, one of the main feasible zones is traditional two-dimensions diagonal area such as the AA’BB’ and CC’DD planes, it indicates that the internal process structure of individual firms should be aligned with the product structure on operational level. And then, from the supply chain perspective, the supply partners also exert equally influence on the match of process and product, especially when the internal process is unable to meet the demand of product customization. That is, the core firms could better locate in the feasible region by integrating internal and external process. Hence, the other feasible zone represents that the internal process and external process can be concordant with product characteristic, and it is a three-dimensional surface such as the ABCD or EFGH surface.

3.4.1 Matching process and product: an operational strategy

Traditional product-process matrix indicates that small batch and various variety product mix (high customization level) should be accordance with the high flexible production process such as job shop, whereas the high volume and commodity product mix (low customization level) needs low-cost and standardization production process such as assembly line [6]. However, in view of the development of advanced technologies and methodologies, which makes the original PPM to be suffered questions [9]. Many authors contended that the feasible zones could be enlarged by adopting the flexible technologies or innovative initiatives [16-17]. Likewise, Ariss illustrated how the high flexible process capability that a firm possesses to overcome the technological or economic constrains in product-process matrix so as to succeed in the market [13]. They asserted that the process flexibility which can be enhanced by flexible technologies or “management innovation” is a key factor to meet the product customization level. Consequently, drawing from the generalization in previous research on PPM, we propose that the production process flexibility should be aligned with the product customization. Meanwhile, the higher level of customization, the higher process flexibility should be coupled. In a similar manner, the other processes (development and delivery process) flexibility also should work in concert with the customization. For example, the “pure customization product” means that the product of all stages (design, fabrication, assembly and distribution) are all largely customized, it is a conventional wisdom to suggests that the entire process sequence comprised product development, production and delivery process maintain the flexibility accordingly to satisfy pure customization requirements. In contrast, as for pure standardization product, the specific process sequence can be taken to map the product structure.

In conclusion, product customization is supposed to degree links with the process flexibility, that is, if customization reached a certain product stage, then the relevant process should keep appropriate flexibility accordingly. Hence, the matching between the multiple process flexibility and product customization is shown in figure 6. It is interesting that the feasible zone in this model is analogous to traditional two-dimensions diagonal area. There are two reasons to explain this phenomenon. Firstly, according to the previous literatures, it is argued that there is a direct positive correlation between the process flexibility capability and product customization level, that is to say, the higher level of customization, the higher process flexibility should be embed. Secondly, we focus on both the connection with process and product from an operational viewpoint. Hence, the research target essentially explains how individual firms match internal process structure and product customization, whereas ignoring the impact of strategic collaboration with supply partners to the feasible area.

![Fig.6 Linking with product customization and process flexibility](image)

### 3.4.2 Matching internal, external process and product: a collaboration strategy

**Collaboration strategy to PPM**

In contrast to the traditional intra-enterprises that only focus on the relationship of internal processes structure and product characteristic, collaboration between supply chain partners as a key and vital strategy for enterprises’ success has received increased
From the Resource-Based View (RBV) theory perspective, three major reasons contribute to the significance of collaboration. First, it is generally agreed that the competitiveness of the enterprise depends on the resource heterogeneity. However, the resource heterogeneity also determines that enterprises hold limited and differentiated resources. Second, the limited resources are given priority to develop the core activity to maintain competence. For these reasons, it is almost impossible for individual enterprises to obtain simultaneously all processes flexibility capability and match product customization with each process. Third, to date, the production efficiency and effectiveness could be both achieved by professional specialization. However, it is uneconomical for enterprises to establish entire processes to content with product customization.

To take better advantage of different enterprises’ heterogeneous core resources so as to make firms locate the feasible zone in the PPM (organize and link process with other firms), collaboration with partners is taken as a valid strategy. Simatupang demonstrated the importance of collaboration among the core firms, suppliers, manufacturers and retailers in supply chain to meet the demand of customers for product variety and just-in-time distribution. Holmstrom indicates that implementing collaborative process network has a positive effect on distribution logistic, product development and manufacture. Hence, to be effective in matching process with product, supply chain partners need to collaborate with each other. And a new feasible region emerges to account for matching internal and external process with product.

Collaboration becomes crucial to explain the match between process and product, especially when the firms stay out of the traditional diagonal area. In order to satisfy the product customization, it is an advisable strategy to integrate external process, in addition to exploiting the internal process. Drawing from the generalizations in the sections above, we propose that the product customization should be aligned with two distinct dimensions of supply chain environment: the internal process and external process. Thus, we summarize this extension of original product-process matrix into three propositions from the collaborative strategy perspective, see figure 7.

**Product development process**

Recent researches on new product development (NPD) have pointed out that to announce new products efficiently and effectively, firms must secure the involvement and support from their partners, such as suppliers. In order to improve the product development performance, firms are increasingly engaging in collaborative product development (CPD) with their external partners. Benefits of CPD include higher return on R&D investments, faster product development, reduced product development cost, increased flexibility, reduced risk, and access to product development capabilities of the supplier. In order to satisfy customers’ customization requirement better, firms which adopt the CPD tactic to continuously update their product offers are on the rise. As a result, the following proposition is proposed:

P1: Collaboration with supply chain partners positively enhance the matching of product development process and product customization.

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**Fig.7 Linking the collaborative process with product**
Production process

It is conventional wisdom that core process should stay in house, while noncore process should be outsourced [38-39]. Indeed, outsourcing is led by strategic consideration to concentrate on optimum distribution of resources and process integration [40]. Specially, production outsourcing such as Original Equipment Manufacturer (OEM) can help companies which take the manufacture process as noncore activity improve quality and efficiency, reduce costs, build process flexibility and enhance business strategy alliances [41-42]. So, firms can attempt to develop collaboration relationship with OEM to deal with the mismatch of production process flexibility with product customization. Basing on the analysis above, we make the second proposition as follows:

P2: Collaboration with supply chain partners positively enhance the matching of production process and product customization.

Delivery process

Higher customized requirement on delivery time and quality makes firms an obligatory to set up a sophisticated logistics, while it is a big challenge for most firms to finish this work by themselves. Then, the idea of collaboration with professional logistic enterprises to improve the distribution performances is a widespread phenomenon; the typical way of cooperation is to source isolated logistics to Third Party Logistic [43-44]. It is notable that it brings many benefits by collaborating with TPL: reduce cost, improve the level of service or increase flexibility toward the changing requirement of customers [45-46]. Hence, if the delivery process was incompatible with product customization, it is a wise choice for firms to corporate with TPL. Then, the last proposition could be concluded:

P3: Collaboration with supply chain partners positively enhance the matching of delivery process and product customization.

4 Case study

4.1 Case study design

On the basis of the above conceptual model construction, next, we will illustrate and verify the propositions by a single qualitative case study. As a more descriptive and exploratory approach, case study research allows for more rich insights into the research object [47]. Like many other qualitative methods, it is characterized by its commitment to collecting data from the context in which social phenomena naturally occur and generate an understanding that is grounded in the perspectives of research participants [48]. Case study research has been recognized as an increasingly important type of research in the area of supply chain management, since traditional research strategies have been often proved to be limited in their applicability and scope. Especially, under the condition that the boundaries between the phenomenon and context are not clearly evident, case study research is enable to analysis the phenomenon deeply within its real life context through empirical investigation [47].

The case study presented in this research is about Lanesync (LC), one of the biggest frozen food marketing companies in China, and in collaboration with Guo Lian Aquatic (GLA), a state-own enterprise (SOE, which become one of Lanesync’s biggest suppliers of sea food), Lanesync’s subsidiaries distribute all over the country, employing five hundred and sixty people. Its main business activity includes frozen food design, production, sale and delivery. Meanwhile, it has a wide range of products consisting of sea food, meat and vegetables, the product structure could be comprised of three categories: “platform” products, alliance products and brand products. Nearly 70 percent of the products go to restaurants, while the remaining 30 percent products go to families. In order to collect data, we investigated and surveyed LC and its partners (such as GLA, suppliers and manufactures) for nearly eight months, including interviewing with department managers, attending conferences, visiting factories and so on.

4.2 Findings discussion of results

The propositions formulated in the conceptual model can now be supported or not, based on the empirical results of the case study.

P1: Collaboration with supply chain partners positively enhance the matching of product development process and product customization. The case study revealed that collaboration with partners can enhance the matching of product development process and product customization. As for product development process, LC has been engaged in collaborative product development (CPD) with their external partners to meet customers’ customized requirements, thus, the members of LC’s Product Development Center (PDC) are made of LC, suppliers and even customers. For example, the outstanding chefs who come from restaurants constitute “chef club” which is a part of PDC to research and develop the new products under customer demand. Furthermore, LC invites their suppliers and customers to participate in “market day 18” to experience and taste the up-to-date products in the 18th of each month. According to “market 18”, it is advantageous for LC to improve and develop product by collecting participants’ suggestions and ideas. With the help of CPD, LC can design and develop high level of customized products quickly, a specific example will be presented. Product named “Family Feast” which aims to specialize families is a kind of pure customized product, customers can order personalized cuisine, for example, customers can pick several dishes from different restaurant at one time, or customers can enjoy the dishes which are cooked according to what they want to. Due to that the “family feast” is a pure customization, then a flexible development process should be coupled. To provide flexible development process, LC cooperates broadly
with restaurants by means of jointly product development (such as “chef club” and “market day 18”) to cope with it, as in figure 8. That is, integrating the internal (LC) and external (restaurants) product development process makes a positive impact on meeting product customization.

P2: Collaboration with supply chain partners positively enhance the matching of production process and product customization.

The case study indicates that collaboration with partners can promote the matching of production process and product customization. Indeed, due to the wide range of products, it is difficult for LC to introduce all types of production lines. Furthermore, on the base of matching relation of PPM, to achieve better production performances, different product characteristics should correspond with different production processes. Consequently, as for LC, it is widespread and valid to map the production process to product structure by cooperating with OEM. By the end of 2012, there are about 50 manufacturers to provide production services for LC. For example (see figure 9), cuisine of “Family Feast” are all cooked by “restaurant alliance” which is organized by restaurant customers of LC to meet the high flexible production process, for developing this issue further, another example will be taken, see figure 9. The new product named “Frozen Butterfly cut Shrimp” which mainly focus on the restaurants clients is a kind of segmented standardized product in high volume, thus a specific production process (such as assemble line) is strongly recommended. However, LC has not any assemble line about shrimp, in order to map production process to this new product, LC collaborates with GLA, its biggest supplier of the raw shrimp and is also a big seafood manufacturer. Meanwhile, LC and GLA jointly update and improve this product, and the production process is outsourced to GLA. As for LC, collaboration with partners not only reduces the logistic costs and production costs, but also improves the product quality and productivity, more important, it is advisable to resolve the problem of mismatching production process effectively.

P3: Collaboration with supply chain partners positively enhance the matching of delivery process and product customization.

The case study identifies that collaboration with partners makes a better matching of delivery process and production customization. To satisfy customers’ desires and expectations, it is very important to deliver the products within the promised deadline, especially the food as products [4]. Nevertheless, there is no perfect logistic system for LC to support delivery process, hence, LC cooperates with the TPL, supplier partners and even individual drivers in different cities to establish the “city distribution system” to insure the on time delivery as well as strengthened logistics capability. For example (see figure 10), as for pure customization product, “family Feast”, one of the attractive characteristics is that customers can enjoy food at home any time, similarly, tailored customization (“every-flavor shrimp” mainly focus on the major hotels, customers can purchase customized shrimps, such as specific shrimps source, size, breed, processing methods, and delivery demands) and segmented standardization (“Frozen Butterfly cut Shrimp”) both are characterized by customized delivery demand, so a flexible delivery process should be employed. In contrary, it is the standardization product (such as “stinky mandarin fish”, a kind of LC’s brand product) that usually marks by high volume, low variety and relatively stable supply demands, so a standardized delivery process can be suited. In order to provide appropriate delivery process for different level of customized products, LC establishes collaborative relationship with different logistic enterprises in different cities, one of biggest driving force in selecting the
partners can be conclude as enhancing the delivery process to fit the product characteristic. In other words, with the help of "city distribution system", the different level of customized products can be connected to applicable processes (flexible or specific delivery process). Thus, the collaborative strategy can enhance the matching of delivery process and product customization.
In general, the core resources and competitiveness of LC respectively are terminal customers and marketing capability instead of product development, production or delivery ability. From the perspective of traditional matrix, LC is supposed to locate far away from the feasible region because of lacking of enough process capability to fit product-variety marketing. Take the “Family Feast” for example, it is a pure customized product which matches the flexible product development, production and delivery process, but, LC cannot be equipped with corresponding processes capability. However, LC introduces this product and achieves a great success by collaboration with supply chain partners to extend its processes capability to enhance the matching of process and product, seeing figure 8. Hence, as for LC, the collaboration strategy makes a positive momentum to push LC to locate in feasible zone.

5 Conclusion

In this paper, we provide a supply chain insight into product-process matrix and attempt to structure a new model to illustrate the impact of collaboration strategy on PPM. Our model develops and extends the original matrix in three way: first, it generalizes the product dimension (originally: product variety or volume) to “customization” of product; second, it generalizes the process dimension (originally: process type) to “flexibility” of process, meanwhile, the process content is enriched from sole production process to new product development, production and delivery process; and third, in view of supply chain environment, it adds an external process dimension. Basing on this model, two major contributions can be concluded. On the one hand, from an operational viewpoint, the model proposes that process (included NPD, production and delivery) flexibility should be aligned with the level of product customization, that is, the higher level of customization, the higher process flexibility should be coupled. On the other hand, from a collaborative strategy viewpoint, this model indicates that collaboration with supply chain partners exerts a positive impact on matching of process and product on operational level, that is, in today’s supply chain collaboration environment, collaboration is crucial for individual firms to break the technological or economic constraints in PPM so as to succeed in the market.

It is acknowledged that there are two main limitations of this study. Firstly, we have investigated only a company in chain to suppose our propositions, more empirical research on large samples to verify and test this model is imperative. Secondly, this model demonstrates that collaboration is vital for firms to map the process to product, but it does not go deep into exploring this regulations of collaboration, such as the ways, intensity, width, depth of collaboration, information sharing, incentive alliance, and further research on these aspects is required in order to develop a more detail and practical model. In addition, there is a prevailing trend towards the integration of products and services into a single customer offering, implying that production means the creation of a combined goods and services product. Further research can aim to incorporate the service into PPM from a supply chain collaboration perspective. Moreover, in addition to case study, more empirical analysis and theoretical development are needed to advance this model.

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