

Relating Strategy of the Organizations to its Pursued Manufacturing Flexibility Strategy

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Abstract

Organizations are classified broadly into three distinct groups based on their operating strategy i.e. Cost leaders or defenders, Differentiators or prospectors and Innovators as identified from the existing literature. Cost leaders emphasize on mass production, differentiators produce on order by identifying needs of the customer and in limited lot sizes while innovators bring cutting edge technologies to the market. Modern manufacturing environments are characterized by varied levels of fluctuations and uncertainty. Hence in order to sustain in the current scenario, organizations need to develop flexible strategies with respect to its organizational structure, operations, manufacturing and supply chain activities. In this paper the major manufacturing flexibility dimensions have been identified from the existing literature and are linked with the different strategic groups. Preliminary empirical investigation lends support to our framework.

Keywords

Relating corporate and manufacturing flexibility strategy

1. Introduction

Today's manufacturing environment is witnessing high degree of uncertainty and the organizations are trying to continuously improve themselves to accommodate the changing customer requirements. Fast and dramatic changes in customer expectations, competition, and technology are creating this increasingly uncertain environment (Zhang et al. 2003). Flexibility is an important aspect to deal with the uncertain and changing environments to sustain in the competitive world. Organizations need to develop flexible strategies in terms of organizational structure, operations, manufacturing and supply chain activities. The strategy of the organization is reflected in its ability to implement the flexibility dimensions. In the present work, an attempt has been made to relate the strategy of the various types of organizations to the flexibility dimensions of operations, manufacturing and supply chain. The appropriate status of each dimension of flexibility with respect to the different strategic group has been stated and empirical investigations from various types of organizations have been carried out, which strongly supports the hypothesis.

2. Literature Review

Zhang et al. (2003) in their work, divided the manufacturing flexibility dimensions into dimensions of manufacturing competence (which includes machine, labor, material handling and routing flexibilities) and dimensions of manufacturing capability (which includes volume flexibility and mix flexibility). The authors developed a research framework that relates manufacturing competence and capability to ultimate customer satisfaction. The developed hypotheses were tested using structural equation modelling. Koste et al. (2004) selected six dimensions of manufacturing flexibility, which were based on Churchill's [J. Market. Res. 16 (1979) 64] earlier work. These dimensions were machine, labor, material handling, mix, new product, and modification. Each dimension comprised of four elements namely range-number (R-N), range-heterogeneity (R-H), mobility (M) and uniformity (U). The authors grouped these four elements of any given manufacturing flexibility dimension into two strategic factors representing "Scope" and "Achievability". These strategic factors were used to compare firms with respect to their flexibility choices, and the trade-offs that the firms make both within and across flexibility dimensions. The authors also developed appropriate scales to measure the concept of manufacturing flexibility and their framework gave a holistic understanding of this complex concept. Lummus et al. (2005) used an internet-based Delphi study involving a group of experts to identify the characteristics of a flexible supply chain. Using these characteristics the authors developed a model of supply chain flexibility. Shukla et al. (2010) investigated sustainability issues of flexible supply chains and studied the effects of flexibility on sustainability. The authors evaluated flexibility in the supply chains in terms of suitability, scalability and sustainability issues. Chang (2012) developed a quantitative model to prioritize the flexibility dimensions of a manufacturing system under the conditions of environmental uncertainty. Singh and Acharya (2013) in their paper highlighted 14 prominent dimensions of supply chain flexibility, which they extracted by an exhaustive review of literature. The authors grouped all these dimensions under inbound, in-house and outbound stages of supply chain and their importance were ranked using AHP method using the responses collected from an FMCG firm. Jain et al. (2013) presented a review of various issues related with manufacturing flexibility i.e. concept, need, dimensions, measurement, relationship among various dimensions, implementation aspect in a company and management of manufacturing flexibility. Kim et al. (2013) investigated the impact of manufacturing flexibility and technological dimensions of manufacturing strategy on responsiveness in the supply chain. The study also examined the role of the business environment on the relationship between manufacturing flexibility and supply chain responsiveness. The results established relationships among various dimensions of manufacturing flexibility. Cheng et al. (2014) studied the drivers of supply chain which directly contributes to organizational flexibility. The authors developed hypotheses relating attributes of the supplier, customer, and focal industries to the use of a flexible organizational strategy. The developed hypotheses were tested using an industry level data and it was shown that heterogeneity of supply sources and scale economies were positively associated with a greater degree of organizational flexibility, in terms of contract manufacturing in the focal industry. The literature review suggests that although a good amount of work has been done on flexibility of manufacturing, operations and supply chain but no work has been attempted to relate the organizational strategy with the flexibility dimensions of the manufacturing activities.

3. Relating Strategy to the different flexibility dimensions of the organizations

Strategy can be defined as the long term plan of action for gaining a competitive edge in a dynamic environment.

(Strategy Type 1) Defenders or Cost Leaders (Miles and Snow, 1978): These companies are the ones that sell their product at prices relatively lower to the other firms within the same target market. With one of the lowest selling prices in the target market, these companies appeal to a broad market. Here product and finance are more important functions. In mass production the cost of product is approximately equal to the sum of materials, manufacturing and labour costs. E.g. McDonalds has been extremely successful by offering basic fast food meals at low prices. They are able to keep prices low through a division of labour that allows it to hire and train inexperienced employees rather than chiefs. These staff savings allow it to sell their food products at the lowest prices.

(Strategy Type 2) Differentiators or Prospectors (Miles and Snow, 1978): These companies are trying to set themselves apart on the basis of a few specific elements. A few elements of differentiation are pricing and product. They use different manufacturing technologies to develop a variety of different products. Manufacturing costs are higher but customers can afford to pay the higher amount. Here marketing and R&D are important functions. E.g. Nike is

considered to be the premier sports gear provider for all the top athletes of the world. Nike's business model is simple: offer high quality products and the customer will be willing to pay the higher prices.

(Strategy Type 3) Innovators (Miller and Roth, 1994): These companies are the ones that lead the market in terms of innovation, design, customer services. They provide products that offer the latest in technology, design and the best customer experience and are the most expensive product in the market. E.g. Apple offers a range of innovative products and wants to create its own ecosystem that is fully compatible with the various OS platforms it has. Apple's iPhone has been the market leader for several years now, an iPhone defines what a Smartphone should be, and accompanied with brilliant marketing and their relentless pursuit of excellent customer service apple has become one of the top electronics and services companies.

Flexibility: Flexibility of an organization is defined as its ability to make whatever internal changes necessary to respond effectively to the changing environment. Upton, (1994) and Upton, (1995) defines flexibility as increasing the range of products available, improving a firm's ability to respond quickly, and achieving good performance over this wide range of products.

Hypothesis (H): It is hypothesized that manufacturing flexibility strategy will depend on organizational strategy.

Table 1: Relating flexibility dimensions to the strategy of the organization

Dimensions	Defenders or cost leaders	Differentiators or prospector	Reason
<p>1. Product flexibility Product flexibility can be defined as the amount of responsiveness (or adaptability) for any future change in a product design, including new products and derivatives of existing.</p>	Low	High	The defender produces a limited set of products directed at a narrow segment of total potential market, within a stable and limited domain while prospectors continuously locates and develops the existing products as per the new market opportunities.
<p>2. Volume flexibility It is the ability to produce above/below the installed capacity for a product. Volume flexibility enables organization to manage their production plan and also enables to produce more while demand is high and low in case of low demand.</p>	High	Low	Production volume is done in anticipation of demand for defenders.
<p>3. New product development/launch flexibility Ability of an organisation to make new products in terms of new design, new specification and new style in order to fulfil the current requirement of customers. Launch flexibility also enables organisation to spread its wings in diversified product range.</p>	Low	High	In case of defenders there is some product development but closely related to organization's current products/service while The prospector's prime capability is that of finding and exploiting new product and market opportunities.
<p>4. Manufacturing flexibility Manufacturing flexibility is the capability to change levels of production rapidly, to develop new products more quickly and more</p>	Low	High	For defenders mass production of a single product, is the prime objective while prospectors types of organisations continuously look for more efficient ways to manufacture the

frequently, and to respond more rapidly to competitive threats.			product as well as bring improvements in the existing products as per the market demand to seek competitive advantage
5. Routing flexibility The different routes (through machines and workshops) that can be used to produce a product in the system.	Low	High	The units flow from one operation point to another which is fixed throughout the whole process in case of defenders while prospectors are more flexible in terms of routing, operation and developing new products. Machine set ups remain unchanged for a considerable long period and mostly unskilled labour trained for a specific type of work in case of defenders while technological flexibility of prospectors (i.e. machine, labour, material handling, capacity, expansion) permits a rapid response to a changing domain.
6. Operation flexibility The ability to produce a product in different ways.	Low	High	
7. Process flexibility The set of products that the system can produce.	Low	High	
8. Expansion flexibility The ability to build out the capacity of a system.	High	High	
9. Machine flexibility	Low	High	
10. Labour flexibility	Low	High	
11. Material handling flexibility The ability to move the products within a manufacturing facility.	Low	High	

Table 2: Relating Strategy and structure

Organisational Structure Dimensions (Pugh et al., 1968)	Cost Leaders	Differentiators	Innovators
Formalisation	High	Low	Low
Specialisation	High	Low	Low
Standardisation	High	Low	Low
Centralisation	High	Low	Low
CWF(Complexity of work flow)	Low	High	High

Miles and Snow, (1978) gave the following reasons for the above table:

- a. In cost leaders, product variety is less and they use mass production, hence standardization is high; jobs are more routine and as a result formalization and centralization is high.
- b. Each job is done most efficiently and they employ more specialists.
- c. There is a streamlined manufacturing and mass production; hence complexity of workflow is less.
- d. In case of differentiators the market uncertainty and product variety is high, hence complexity of workflow is high.
- e. Differentiators have to constantly adapt and rethink their strategies as per the changing environment and as a result Formalization, Specialization, Centralization, and Standardization are low.

4. Empirical Investigation

In order to examine the validity of the developed hypothesis, an appropriate questionnaire consisting of the dimensions of organizational strategy and manufacturing flexibility was prepared to capture the responses from senior executives of various manufacturing organizations who are responsible for strategy, supply chain and production planning formulation of their respective organizations. A total of nine completely filled questionnaires were obtained from diverse manufacturing organizations. These firms have been renamed as Firm 1 (F1), Firm 2 (F2), Firm 3 (F3), Firm 4 (F4), Firm 5 (F5), Firm 6 (F6), Firm 6 (F6), Firm 7 (F7), Firm 8 (F8) and Firm 9 (F9). F1 is a multi-company, multi-product and a multi-location enterprise which manufactures high quality, environment-friendly products which ranges from bicycles to electric vehicles. F2 is a prominent textile conglomerate of north India with multiple production facilities. F3 is a leading and pioneer company, manufacturing herbal veterinary and human health care products. F4 is a public sector enterprise producing refined copper metal in the form of finished products as continuous cast copper rods, copper cathodes and copper wires. F5 is large mining and Exploration Company mainly dealing with copper, lead and zinc. F6 is a fast growing group dedicated to design, manufacture and supply of steam boilers, thermic fluid heaters, hot water generators, hot air generators and allied heat transfer equipment. F7 is a leading manufacturers and exporters of high quality knitted garments in north India. F8 is a large manufacturing hub with a diverse product range offering consumer, office and industrial products and services of highest quality. The responses obtained from the senior executives of the respective organizations are tabulated in Table 3. The responses to questions on strategy related to product variety were captured using a likert scale of 1 to 5 depicting not important-1 to critically important-5.

Table 3: Tabulation of the responses on organizational strategy (based on product variety)

Organizational Strategy (On the basis of Product Variety)													
				A	B	C	Avg						
	Questions Used	F1	F2	F3	F4			F5	F6	F7	F8	F9	
1	The capability of your organization to deliver a broad product line is	4	4	3	4	2	3	3.0	5	1	4	3	5
2	The strategy of your company to aggressively innovate product is	5	2	3	4	2	4	3.3	4	4	4	3	5
3	Increasing the market share of your company by introducing innovation and change is	4	5		4	2	5	3.7	4	4	4	4	3
4	For your organization maintaining industry leadership by product/service/process or management innovation is	5	4	5	4	3	5	4.0	5	4	3	4	4
5	The capability of your organization NOT to compete on price.		1		3	3	2	2.7	4		3	3	2
6	The capability of your organization to make rapid design changes or introduce new products quickly is	4	2	2	4	2	2	2.7	4	5	4	4	2
7	The capability of your organization to respond to swings in volume is	5	4		4	2	4	3.3	5	3	2	3	3
	Total	27	22	13	27	16	25	22.7	31	21	24	24	24
	Average	4.5	3.1	3.2				3.2	4.4	3.5	3.4	3.4	3.4

The average value of the responses on strategy for each firm is tabulated in the last row of the table 3. Firms can be differentiated based on this average value. Firms having an average value of three or less than three are classified as defenders or cost leaders and firms having the average value greater than three are classified as prospectors or

differentiators. Accordingly all the firms are classified as prospectors based on strategy i.e. product variety as shown in Table 4.

Table 4: Classification of firms based on average value

Prospectors (Average>3)	Defender (Average<3)
Firm 1	
Firm 2	
Firm 3	
Firm 4	
Firm 5	
Firm 6	
Firm 7	
Firm 8	
Firm 9	

Next, the responses obtained from the various firms on manufacturing/ operations flexibility dimensions were considered for analysis. Eleven major flexibility dimensions on manufacturing/operations are taken into consideration which are described earlier in Table 1. The scores obtained on these dimensions using a five point likert scale are summarised and tabulated in Table 5.

Table 5: Tabulation of the responses on manufacturing/operations flexibility obtained from various firms

Manufacturing flexibility dimensions											
				A	B	C	Avg				
Flexibility Dimensions	F1	F2	F3	F4				F5	F6	F7	F8
Product flexibility	4	3	3	3	1	3	2.3	4	4	4	3
Volume flexibility	5	4	4	4	3	3	3.3	3	5	3	3
New product development/launch flexibility	4	3	4	3	2	1	2.0	4	4	4	4
Manufacturing flexibility	4	3	5	3	2	1	2.0	4	5	2	3
Routing flexibility	2	3	5	3	3	3	3.0	4	4	3	3
Operation flexibility	3	2	1	3	2	1	2.0	2	5	2	4
Process flexibility	3	3	1	3	2	3	2.7	4	4	4	4
Expansion flexibility	3	2	3	4	2	4	3.3	4	4	2	2
Machine flexibility	4	3	1	3	2	3	2.7	4	5	4	3
Labour flexibility	3	3	5	3	3	3	3.0	4	5	3	3
Material handling flexibility	3	3	4	3	4	3	3.3	5	5	3	3
Total	38	32	36				29.7	42	50	34	35
Average	3.5	2.9	3.3				2.7	3.8	4.5	3.1	3.2
Strategic Group	Prospector	Defender	Prospector	Defender				Prospector	Prospector	Prospector	Prospector

Again, the average scores derived from manufacturing/operations flexibility dimensions has been used to classify the firms into strategic groups (Table 5). Accordingly firms F1, F3, F5, F6, F7, and F8 are classified as prospectors as the average value of flexibility dimensions are greater than three and firms F2, F4 are classified as defenders. Now, comparing the strategic classification of all the nine firms under consideration based on product variety and manufacturing/operations flexibility, it can be seen that seven firms are classified under same strategic group in

both type of dimensions (Table 6). This gives a strong evidence to our hypothesis which states that flexibility strategy will depend on organizational strategy.

Table 6

Supporting Hypothesis	Not Supporting Hypothesis
Firm 1	Firm 2
Firm 3	Firm 4
Firm 5	
Firm 6	
Firm 7	
Firm 8	

5. Conclusion

In this paper, we argue that firms with similar strategic orientation pursue similar flexibility (manufacturing) strategies. The flexibility issue is an essential aspect to be integrated within operations, supply chain and manufacturing activities when simultaneously considering dynamic environments and exploit competitive advantages. A pilot study lends support to the framework developed in this paper. We plan to undertake a more exhaustive empirical investigation in near future and report its findings.

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References

- Zhang. Q., Vonderembse, M.A., and Lim, J.S., Manufacturing flexibility: defining and analysing relationships among competence capability and customer satisfaction, *Journal of Operations Management*, vol. 21, no.2, pp. 173-191, 2003.
- Raymond E. Miles, and Charles C. Snow, Organizational, Strategy, Structure and Process, *Academy of Management Review*, July 1978, pp. 546-562, 1978.
- Miller, G.M. and Roth, A.V., A Taxonomy of Manufacturing Strategies, *Management Sciences*, vol. 40, no.3, pp. 285-304, 1994.
- Upton, D.M., The management of manufacturing flexibility, *California Management Review*, winter, pp. 72-89, 1994.
- Upton, D.M., What really makes factories flexible? , *Harvard Business Review*, vol. 73, no. 4, pp. 74-84, 1995.
- Pugh, D. S., Hickson, D. J., Hinings, C. R., & Turner, C. (1968). Dimensions of Organization Structure. *Administrative Science Quarterly*, pp. 65 - 105.
- Koste, L.L., Malhotra, M.K. and Sharma. S., Measuring dimensions of manufacturing flexibility, *Journal of Operations Management*, vol. 22, no. 2, pp. 171-196, 2004.
- Lumms, R.R., Vokurka, R.J. and Duclos, L.K., Delphi study on supply chain flexibility, *International Journal of Production Research*, vol. 43, no.13, pp. 2687-2708, 2005.
- Shukla, A.C., Deshmukh, S.G. and Kanda, A., Flexibility and Sustainability of Supply Chains: Are They Together, *Global Journal of Flexible Systems Management*, vol. 11, no.1-2, pp. 25-38, 2010.
- Chang, A.Y., Prioritizing the types of manufacturing flexibility in an uncertain environment, *International Journal of Production Research*, vol. 50, no. 8, pp. 2133-2149, 2012.
- Singh, R.K. and Acharya, P., Supply Chain Flexibility: A Framework of Research Dimensions, *Global Journal of Flexible Systems Management*, vol. 14, no. 3, pp. 157-166, 2013.
- Jain, A., Jain, P.K., Chan, F.T.S. and Singh, S., A review on manufacturing flexibility, *International Journal of Production Research*, vol. 51, no. 19, pp. 5946-5970, 2013.

Kim, M., Suresh, N.C., Hillmer, C.K., An impact of manufacturing flexibility and technological dimensions of manufacturing strategy on improving supply chain responsiveness: Business environment perspective, *International Journal of Production Research*, vol. 51, no. 18, pp. 5597-5611, 2013.

Cheng, L.C., Cantor, D.E., Grimm, C.M. and Dresner, M.E., Supply Chain Drivers of Organizational Flexibility- A Study of US Manufacturing Industries, *Journal of Supply Chain Management*, vol. 50, no.4, pp. 62-75, 2014.

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