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Antecedents and Consequence of Strategic Manufacturing Effectiveness: A Conceptual Framework

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Abstract

This paper has identified and operationalised the main factors that affect strategic manufacturing effectiveness. The process of identifying the indicators for each factor is restricted to only those that are theoretically supported. Having a small pool of items to measure each factor is helpful in the interpretation of the results. First, the indicators for the five factors affecting strategic manufacturing effectiveness were generated, based on the work of Wheelwright and Hayes (1985) and other researchers. Then the indicators for strategic manufacturing effectiveness construct were identified based on the list of manufacturing improvement programmes which was compiled by researchers involved in the Manufacturing Futures Survey Project. With respect to manufacturing competence, it is measured through the importance and strength in manufacturing competitive priorities. Finally, interrelationships amongst the factors were discussed and future research directions were identified.

Keywords: Competitive Capabilities, Manufacturing Competence, Manufacturing Improvement Programmes, Manufacturing Strategy, Proactiveness, Strategic Manufacturing Effectiveness,

Introduction

Hayes and Wheelwright (1984) suggested that even though strategic manufacturing effectiveness is developed along a continuum, there are four stages that are identifiable, which can reveal the firm's position and the required transformations in order to move it to the next stage or to keep it from sliding to a lower stage. At one end of the stages, production offers very little support to a firm's success, whereas at the other end it contributes significantly to the competitive advantage of the firm.

This four-stage model, that Hayes and Wheelwright (1984) proposed, describes the possible levels of strategic manufacturing effectiveness within organisations. What really decides the strategic effectiveness of a particular manufacturing unit is a combination of critical factors. As Wheelwright and Hayes (1985) suggested, "a given operation may be - and often is - composed of factors that are themselves at different levels of development. What determines the overall level of the operation is where the balance among these factors falls".

Rowbotham and Barnes (2004, p. 651) noted that "the classification proposed by Hayes and Wheelwright seems to be widely accepted amongst operations management academics, being included in most syllabi, but has little reported application at the level of the individual company. In order to reap the benefits offered by the model, practitioners require a reliable means to make use of its concepts within their own organisations."

Therefore, the objective of this paper is to identify and operationalise the factors affecting strategic manufacturing effectiveness within a conceptual framework that shows the interrelationships amongst the factors and their consequences.

Factors Affecting Strategic Manufacturing Effectiveness

Even though Hayes and Wheelwright (1984) did not explicitly identify the factors that affect strategic manufacturing effectiveness in a systematic way, they did, however, point to them when they were describing the characteristics of the four stages. A brief description of these factors is presented below:

1. The Attitude of Top Managers Towards Manufacturing

This factor was expressed many times during the discussion of the four stages. For example, Hayes and Wheelwright (1984) suggested that for stage one firms, top managers 'try to minimise their involvement with, and thus their perceived dependence on, manufacturing'.

Additionally, they consider manufacturing to be incapable of influencing competitive success. They encourage manufacturing to follow blindly industry practice in matters regarding the work force, equipment purchases, and capacity additions without understanding how manufacturing can provide competitive advantage.

Chang et al. (2005) noted that when top managers have clear understanding and awareness of the actual manufacturing capabilities, they will be better placed to initiate proper launch and introduction of new products. This involvement of the top managers could take place through information exchange and shared communications with the manufacturing function (Papke-Shields and Malhotra, 2001).

Narayanan et al (2002) concluded from a three-year intensive study of fast cycle teams in the pharmaceutical industry that the role played by top management is a critical success factor and implementation starts with them.

2. Involvement of Manufacturing Managers in Setting the Strategic Direction of the Firm

Hayes and Wheelwright (1984) noted that one of the characteristics of stage three firms is that 'manufacturing managers take a broad view of their role by seeking to understand their company's business strategy and the kind of competitive advantage it is pursuing'. For firms in lower stages, Hayes *et al.* (1988) found that part of the reason manufacturing managers are not involved in shaping corporate policies is because they spend most of their time in dealing with routine operational matters. They just do not have adequate knowledge of how to view their roles from a strategic perspective.

A number of researchers (e.g., Acur and Bititci (2000), Kaplan and Norton (2001)) have observed that in order for people to commit to a strategy, they need to believe and be involved in it.

Chang et al. (2004, p. 1120) observed that "involving the manufacturing executive in the business strategy formulation allows the manufacturing function personnel to have a clear picture of the firm's product positioning and its correlation to equipment purchases." They also noted that active involvement of manufacturing managers in business-level decisions enhances new product and volume flexibility and a firm's ability to adjust total output levels to accommodate fluctuations in market demand.

Papke-Shields and Malhotra (2001) observed a direct effect of the involvement of manufacturing managers on the alignment between manufacturing and business strategies. This alignment, as they noted, is “an important mediating variable in the relationship between the strategic involvement of the production function and performance (p. 227).

Decoene and Bruggeman (2006, p. 430) further noted that when there is clarity of linkage between manufacturing and business strategies, it will mean: "(1) senior management and management of the manufacturing function agree on the goals of the company and of the manufacturing function; (2) the manufacturing function supports the strategic direction of the company (Papke- Shields and Malhotra, 2001); and (3) management can prevent the emergence of any disparity between an intended business strategy at the corporate level and a realized manufacturing strategy at the functional level (Kaplan and Norton, 1996)”.

3. Formulating Manufacturing Strategy

According to Hayes and Wheelwright (1984), this factor is absent in stage one and two firms, whereas stage three firms formulate ‘manufacturing strategy complete with plant charters and mission statements to guide manufacturing activities over an extended period of time’ (p. 102).

Acur and Englyst (2006) observed that there are very few empirical studies that have actually addressed the formalisation of manufacturing strategy, however in order to achieve acceptance and commitment it is important that the document describing the resultant strategy to be clear and should enclose enough details in terms of actions and responsibilities. One issue that they have identified is “how strategy formulation processes can be assessed if the companies have different perspectives on their phases of strategy formulation process; either logical vs. creative (strategic thinking), intended vs. emerged (strategic planning) and, revolutionary vs. evolutionary (embedding)”.

Lowson (2005, p. 649) noted that there is theoretical and empirical evidence that a formalised manufacturing strategy "offers a substantial contribution to support competitive positioning (Chase et al., 2004; Russell and Taylor, 2003)”.

The study of Acur et al. (2003) lends support to the notion that "a formalised manufacturing strategy enhances/ facilitates the translation of competitive criteria, via manufacturing improvement goals into action programs" (p. 1137).

4. Proactiveness

Hayes and Wheelwright (1984) noted that one of the characteristics of stage three firms is that they are ‘on the lookout for longer term developments and trends that may have a significant effect on manufacturing’s ability to respond to the needs of other parts of the organisation’ (p. 102). They also suggested that stage four firms ‘anticipate the potential of new manufacturing practices and technologies and seek to acquire expertise in them long before their implications are fully apparent’ (p. 103).

5. Co-ordination between Manufacturing and Other Functions

This factor is more apparent in stage four firms where ‘there are extensive formal and informal horizontal interactions between manufacturing and other functions that greatly facilitate such activities as product design, field service, and sales training’. (Hayes and Wheelwright, 1984, p.103). Also co-ordination can extend beyond a

firm's boundary to include its suppliers. Hayes and Wheelwright (1984) noted that for stage one firms 'manufacturing operation can appear clumsy and unprepared when confronted with such straightforward tasks as helping suppliers solve problems' (p. 101).

This co-ordination between manufacturing and other functions should lead to the development of resources and capabilities through learning and cross fertilisation of ideas "based on cross- training and suggestion systems, external learning from customers and suppliers, and proprietary processes and equipment developed by the firm" Voss (2005).

Chang et al. (2005, p. 1120), from their field study, observed that "routine meetings with members from manufacturing and marketing (e.g. staff meetings, interlock meetings, and quarterly business review meetings) to deal with order fulfilment matters are helpful in responding to rapid demand variations".

The integration of manufacturing and design functions can give a boost to new product development when manufacturing is involved early in the process through the reduction of the numbers of manufactured parts and engineering changes. (Zhang and Cao, 2002). Also, when marketing managers understand issues related to production schedule and capacity, they will have the knowledge to negotiate with their customers on volume, thus smoothing out variations in demand (Canel and Das, 2002). That will enable manufacturing to take more control of order fluctuations

Consequences of the Five Factors

The five factors through there presence or absence will affect strategic manufacturing effectiveness. That in turn will affect how competent manufacturing is in supporting business strategy. This concept of 'manufacturing competence' is explained later when deriving its indictors. The cause and affect relationships amongst the seven constructs are shown in Figure 1 below.

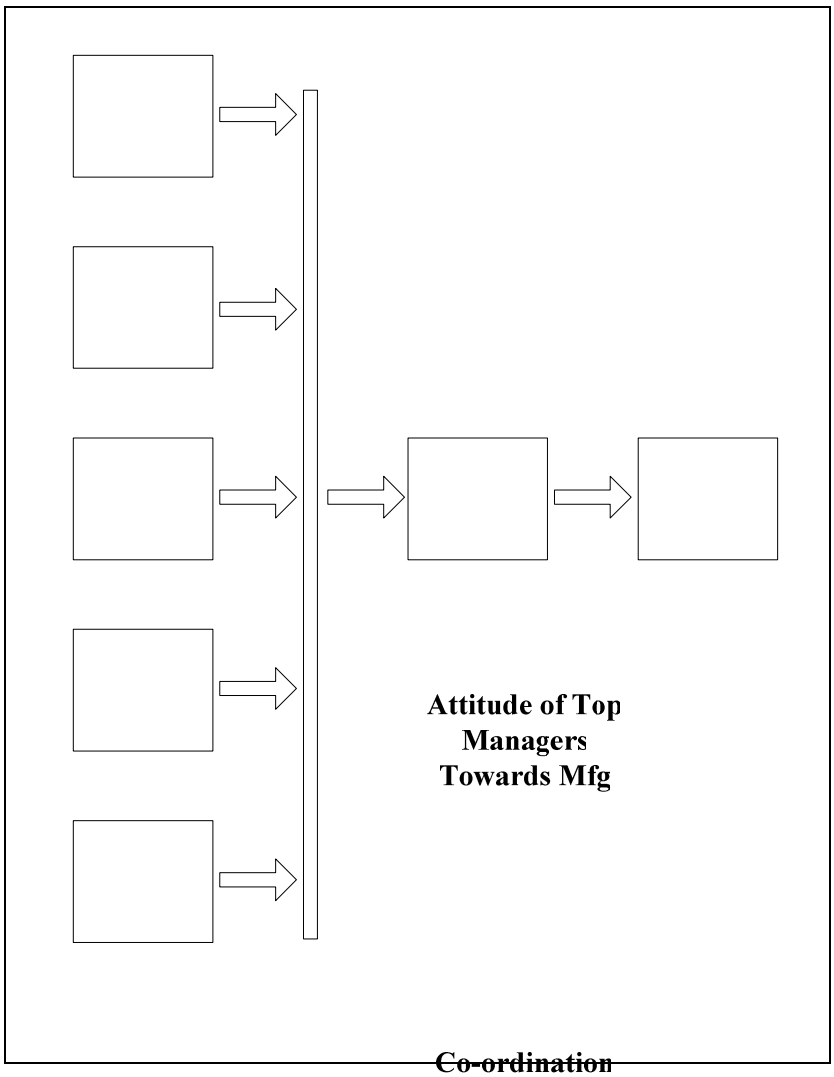

Figure 1: Antecedents and Consequents of the Strategic Manufacturing Effectiveness

The next few sections identify the indicators for the five antecedent factors, strategic manufacturing effectiveness and manufacturing competence. The tables that show the indicators also include the type of anticipated effect that each indicator will have on a factor. The (+) sign indicates positive effect and the (-) sign denotes negative effect.

Indicators for the Five Factors Affecting Strategic Manufacturing Effectiveness

During the process of generating the indicators, two points, which were suggested by Swamidass and Newell (1987), were followed. The first point is that only the items that are theoretically supported must be included as indicators (Asher, 1981; Heise, 1975). The second point is that the number of indicators must be kept to a minimum (Young, 1977).

There are two main advantages of reducing the number of indicators. One is that if the indicators are structured within a framework and presented in a questionnaire to potential respondents for empirical validation, the chances of achieving a higher response rate are increased since the questionnaire becomes more manageable. However the more important advantage is that building a theoretical model with fewer items can help in the interpretation of the results (Bentler and Chou, 1987).

1. Indicators for the Attitude of Top Managers Towards Manufacturing

This factor is stressed by Wheelwright and Hayes (1985) during their presentation of the characteristics of the four stages in their framework. They observed that top managers in stage one firms consider manufacturing to be neutral and incapable of influencing competitive success. Top managers try also to minimise their involvement with and dependence on manufacturing.

In stage two firms, they encourage manufacturing to follow industry practice, and view economies of scale as the most important source of production efficiency. They also consider resource allocation decisions to be the best way of addressing major strategic concerns in manufacturing.

Table 1: Indicators for the Attitude of Top Managers Towards Manufacturing
(Source of the indicators is Wheelwright and Hayes, 1985)

No.	Indicators	Effect
1.	Top managers consider manufacturing to be neutral and incapable of influencing competitive success.	(-)
2.	They minimise their involvement with, and thus their perceived dependence on, manufacturing.	(-)
3.	They encourage manufacturing to follow industry practice in matters regarding the work force, equipment purchases, and capacity additions.	(-)
4.	They view economies of scale related to the production rate as the most important source of manufacturing efficiency.	(-)
5.	They regard resource allocation decisions as the most effective means of addressing the major strategic issues in manufacturing	(-)
6.	They communicate frequently with the manufacturing managers to understand the problems facing manufacturing and help to solve them	(+)

In higher stages, top managers make efforts to communicate as often as they can with the manufacturing managers in order to understand the problems facing manufacturing and help to solve them. These observations formed the basis for six indicators that are designed to measure the attitude of top managers towards manufacturing. They are shown in Table 1.

2. Indicators for the Involvement of Manufacturing Managers in Setting the Strategic Direction of the Firm

Table 2 shows five indicators which are hypothesised to measure this factor. Wheelwright and Hayes (1985) provided the first indicator through their observation that manufacturing managers in stage three and four firms seek to understand their company's business strategy and the kind of competitive advantage it is pursuing.

Hill's (1993) findings about the role played by manufacturing managers contributed three indicators. He observed that manufacturing managers in many firms view their roles as being reactive. Moreover, they involve very late in corporate policy and when they get the chance to represent manufacturing in corporate debates they do not express themselves well.

Table 2: Indicators for the Involvement of Manufacturing Managers in Setting the Strategic Direction of the Firm

No.	Indicators	Effect
1.	Manufacturing managers seek to understand their company's business strategy and the kind of competitive advantage it is pursuing (Source: Wheelwright and Hayes, 1985).	(+)
2.	Manufacturing managers view their roles as being reactive (Source: Hill, 1993).	(-)
3.	Manufacturing managers involve very late in corporate policy debates (Source: Hill, 1993).	(-)
4.	Manufacturing managers do not express themselves well in corporate policy debates (Source: Hill, 1993).	(-)
5.	Manufacturing managers spend most of their time in dealing with day-to-day operating issues (Source: Hayes *et al.*, 1988).	(-)

The third source used is Hayes et al. (1988). They noted that manufacturing managers in stage two firms spend most of their time in dealing with day to day operating issues; whereas in stage four firms, much more time is spent on strategic concerns. Thus, Hayes et al. suggest that there is an inverse relationship between the amount of time a manufacturing manager spends on the day to day running of operations and his involvement in setting the strategic direction of his firm.

3. Indicators for the Emphasis on Formulating Manufacturing Strategy

This factor is measured by six indicators. The first one is the formal development of manufacturing strategy. The second one, which is related to the first indicator, is the use of outside experts to help tackle strategic issues involving manufacturing. Both of these indicators are based on the work of Wheelwright and Hayes (1985).

As shown in Table 3, the third indicator is based on the work of Venkatraman (1989) who developed a strategic orientation construct of business firms. This indicator is 'developing thorough analysis when confronted with a major decision'.

The other three indicators are contemplated once again by Wheelwright and Hayes (1985) who observed that manufacturing functions in stage three firms screen their decisions to make certain that they are compatible with the organisation's competitive strategy.

Table 3: Indicators for the Emphasis on Formulating Manufacturing Strategy

No.	Indicators	Effect
1.	Manufacturing strategy is formally formulated (Source: Wheelwright and Hayes, 1985).	(+)
2.	Develop thorough analysis when confronted with a major decision (Source: Venkatraman, 1989).	(+)
3.	Screening decisions to be sure they are consistent with competitive strategy (Source: Wheelwright and Hayes, 1985).	(+)
4.	Employing detailed measurements and controls of operating performance (Source: Wheelwright and Hayes, 1985).	(-)
5.	Incorporating non-financial considerations in the capital budgeting process (Source: Wheelwright and Hayes, 1985).	(+)

Moreover, in stage four, firms analyse their manufacturing decisions regarding capital investments by incorporating non-financial considerations. On the other hand, firms in stage one employ only detailed financial measurements and controls of operating performance. Such a system of controlling manufacturing performance has been criticised by some researchers (e.g. Kaplan, 1984) as one of the causes that can undermine production.

4. Indicators for Proactiveness

The work of Venkatraman (1989) is utilised also for measuring proactiveness. Two of the indicators of his proactiveness and riskiness dimensions are found to be relevant for this factor. They are 'constantly seeking new opportunities related to the present operations' and 'operations can be generally characterised as high-risk'.

The third indicator is provided by Wheelwright and Hayes (1985) who noticed that firms which have reached stage four status acquire expertise in new manufacturing practices and technologies long before their values and importance are evident. The indicators are shown in Table 4.

Table 4: Indicators for Proactiveness

No.	Indicators	Effect
1.	Constantly seeking new opportunities related to the present operations (Source: Venkatraman, 1989).	(+)
2.	Operations can be generally characterised as high-risk (Source: Venkatraman, 1989).	(+)
3.	Anticipate the potential of new manufacturing practices and technologies and seek to acquire expertise in them long before their implications are fully apparent (Source: Wheelwright and Hayes, 1985).	(+)

5. Indicators for Co-ordination between Manufacturing and Other Functions

Co-ordination between manufacturing and other functions in a firm usually takes place in stage four firms. Wheelwright and Hayes (1985) observed that in such firms, there is interactive development of business, manufacturing, and other functional strategies. There are also various interactions between manufacturing and other functions in order to help such efforts as product design, field service, and sales training. This process of co-ordination can also help the transfer of 'know-how' from other functions to manufacturing and vice versa.

Positive and fruitful co-ordination does not have to be only between functions within a firm, but can extend to suppliers also. Wheelwright and Hayes (1985) noted that firms in higher stages of manufacturing effectiveness go beyond the firm's boundary and try to co-ordinate efforts with their suppliers, especially offering to help solve whatever problems their suppliers encounter which directly or indirectly involve the production and supply of their parts. Thus, four indicators are identified for this factor and they are presented in Table 5.

Table 5: Indicators for the Co-ordination between Manufacturing and Other Functions (Source of the indicators is Wheelwright and Hayes, 1985)

No.	Indicators	Effect
1.	Interactive development of business, manufacturing, and other functional strategies.	(+)
2.	Extensive interactions between manufacturing and other functions to facilitate product design, field service, and sales training.	(+)
3.	Transfer of 'know-how' from other functions to manufacturing.	(+)
4.	Helping suppliers to solve problems.	(+)

Indicators for Strategic Manufacturing Effectiveness

Pun (2004) observed, “the contributions of manufacturing are realised through the deployment of strategic decisions in a number of manufacturing areas, so as to align the company’s skills and resources with its competitive strategy and enhance its ability to compete on dimensions generally classified as quality, cost, delivery and flexibility (Platts and Gregory, 1990; Pun et al., 2004)”.

In addition, Lowson (2005, p.649) noted that "it seems clear that an operations strategy, like any strategy, revolves around a pattern of choices. These decisions are less concerned with individual day- to- day, tactical activities and more with the whole transformation system that is part of the organisation and the resources, competencies and capabilities needed (Lowson, 2003)".

Therefore, strategic manufacturing effectiveness is a construct that can be represented and measured through the extent of support that the manufacturing function provides to the competitive advantage of a firm in its marketplace by means of its emphasis on choices and programmes that improve manufacturing.

The indicators of strategic manufacturing effectiveness are based on the list of manufacturing improvement programmes which was compiled by Ferdows and DeMeyer (1990) and other researchers working in the Manufacturing Futures Survey Project. This list is shown in Table 6. The number of indicators in this list is thirty nine. From an empirical point of view, this number is considered to be too high. Hence an effort is made to strike a balance between parsimony and comprehensiveness.

Table 6: List of Manufacturing Improvement Programmes
Source: Ferdows and DeMeyer, (1990)

1. Giving workers a broad range of tasks	23. Narrowing product lines/ standardising
2. Giving workers more planning responsibility	24. Defining a manufacturing strategy
3. Changing labour management relationships	25. Integrating information systems between manufacturing and other functions
4. Manufacturing reorganisation	
5. Worker safety	
6. Worker training	26. Integrating information systems within manufacturing
7. Management training	
8. Supervisor training	27. Vendor quality
9. Preventive maintenance	28. Reconditioning of physical plants
10. Zero defects	
11. Manufacturing lead-time reduction	29. Just-in-Time
	30. Robots
12. Vendor lead-time reduction	31. Flexible manufacturing systems
13. Computer-aided manufacturing	
14. Computer-aided design	32. Closing plants
15. Reducing set-up/changeover time	33. Statistical quality control (product)
16. Value analysis/product	34. Statistical quality control

redesign
17. Group technology
18. Capacity expansion
19. Reducing size of manufacturing units
20. Plant relocation
21. Developing new processes for new products
22. Developing new processes for old products
(process)
35. Improving new product introduction capability
36. Quality circles
37. Automating jobs
38. Production/inventory control systems
39. Reducing the size of manufacturing work force (including hourly and salaried)

That is necessary in order to eliminate those items that are repetitive and also exclude the ones that are general and cannot be easily interpreted.

Examples of items that are repetitive are job enrichment, giving workers more planning responsibility, and giving workers a broad range of tasks. With respect to these three indicators, only the last one is kept since it covers the other two items.

Examples of items that are not included are manufacturing reorganisation and changing labour- management relationships. These two actions are too general and the variations between firms in implementing such programmes cannot be interpreted readily. They both imply a change from one state to another, however it is not known what are the characteristics of the initial state and how different they are from the new state that has been arrived at through 'changing labour-management relationships' or 'manufacturing reorganisation'. Table 7 shows some of those items which were not included and the reasons for their exclusion.

Table 7: Manufacturing Improvement Programmes that are not Included

Manufacturing Improvement Programmes	**Reasons for Exclusion**
Manager training	This item is represented by 'Supervisor training'
Changing labour management relationships, Manufacturing reorganisation, Reducing size of manufacturing units	These items are too general and might not be applicable to a wide range of firms, and the variations between firms are not easily interpretable.
Automating jobs, Group technology, Robots	For reasons of parsimony, these items are not included and only one item is kept which is 'implementing FMS' to represent the implementation of advanced manufacturing technology.
Giving workers more planning responsibility, job enrichment	These items are represented by 'giving workers a broad range of tasks'.
Reducing set-up/ changeover time, Vendor lead-time reduction	These items are represented by 'manufacturing lead-time reduction'.

Thus the complete list of manufacturing improvement programmes that are used to indicate strategic manufacturing effectiveness are those shown in Table 8.

Table 8: Manufacturing Improvement Programmes that Represent Strategic Manufacturing Effectiveness
Source: Ferdows and De Meyer (1990)

No.	Manufacturing Choice
1.	Manufacturing lead time reduction
2.	Just-in-Time (JIT)
3.	Introduction of Flexible manufacturing systems
4.	introduction of CAD/CAM
5.	Developing new processes for new products
6.	Developing new processes for old products
7.	Capacity expansion
8.	Reconditioning of physical facilities
9.	Reducing the size of manufacturing work force
10.	Plant relocation or closing plants
11.	Supervisor training
12.	Worker training
13.	Worker safety
14.	Giving workers a broad range of tasks
15.	Statistical quality control
16.	Vendor quality
17.	Zero defects
18.	Quality circles
19.	Preventive maintenance
20.	Integrating systems across areas
21.	Integrating systems within manufacturing
22.	Improving new product introduction capability

Indicators for Manufacturing Competence

A firm that positions itself in stage four according to Wheelwright and Hayes' framework should perform better than a similar firm which is in a lower stage. Thus, strategic manufacturing effectiveness leads to better firm performance.

Feller (2002) observed that "the value of performance measurement in fostering accountability, contributing to improved organization performance, and communicating an organization's goals and results is limited by: first, the imperfect state of knowledge about what these measures should be, how to construct them, and second, the administrative feasibility and cost- effectiveness of data collection and analysis, and political and organizational contexts" (p. 449).

Therefore, the performance outcome of strategic manufacturing effectiveness can possibly be examined at business or functional levels of an organisation. It can be examined at the business level through financial performance measures. Also, it can be explored at the marketing level through such measures as market share and market growth. However, since this paper is exploring strategic effectiveness of the

manufacturing function, the direct impact is expected to be at the manufacturing level, and thus manufacturing performance measures are considered. The other reason for considering only manufacturing performance measures is that financial and marketing performance measures are usually affected by the contribution of other functions. Consequently, it is difficult to isolate the contribution of manufacturing effectiveness on such measures.

Kim and Arnold (1993) noted that the field of manufacturing strategy does not have a well defined set of performance measures to test frameworks or theories, and to measure overall manufacturing capability. This predicament was recognised before by Nemetz (1990) who stated that 'the manufacturing environment has changed in such a way that old performance measures are no longer meaningful. Neither the academic nor the industrial community has yet established new standards for assessing general performance. Without publicly reported, standardised measures of performance, there is no straightforward method for conducting manufacturing research' (p. 64).

The concept of 'manufacturing competence' has been proposed in the literature as a response to the absence of a viable measure of manufacturing performance. Initially it was proposed by Cleveland *et al.* (1989), and then extended and refined by Vickery *et al.* (1993) and Kim and Arnold (1993). The three studies have shown that manufacturing competence is a reliable measure of manufacturing performance, and it positively affects business performance.

Manufacturing competence is measured through the importance and strength in manufacturing competitive capabilities. The progress of thinking about these capabilities is shown in Table 9. It is obvious that the important categories of competitive capabilities have stayed almost unchanged since Wheelwright (1978) with Buffa (1984) adding service as another category. Accordingly, the dominant categories are cost, dependability, flexibility, quality and service. They are the same ones proposed by Buffa (1984).

Table 9: Categories of Competitive Capabilities as Viewed by Researchers in Manufacturing Strategy

Researchers	Competitive Priorities
Skinner (1969)	Productivity, Quality, Return on investment, Service
Wheelwright (1978)	Dependability, Efficiency, Flexibility, Quality
Buffa (1984)	Cost, Dependability, Flexibility, Quality, Service
Hayes and Wheelwright (1984)	Cost, Dependability, Flexibility, Quality
Hill (1985)	Delivery, Delivery Speed, Flexibility, Price, Quality, Reliability
Hayes *et al.* (1988)	Cost, Dependability, Flexibility, Quality

This paper proposes the use of the same categorisation that was operationalised by Kim and Arnold (1993) through fifteen competitive capabilities as shown in Table 10.

Table 10: Manufacturing Competitive Capabilities
Source: Kim and Arnold (1993)

Cost:	
1.	Manufacture with lower cost than competitors
Flexibility:	
2.	Make rapid design changes
3.	Introduce new products quickly
4.	Make rapid volume changes
5.	Make rapid product mix changes
6.	Offer broad line of products
Quality:	
7.	Manufacture with consistently low defect rates
8.	Provide high performance products
9.	Offer reliable products
Delivery:	
10.	Provide fast delivery of products
11.	Deliver products on time as promised
Service:	
12.	Provide effective after- sales services
13.	Provide product support effectively
14.	Make products easily available (broad distribution)
15.	Customise products to customer needs

Discussion of the Conceptual Framework

Figure 2 shows the seven constructs in a theoretical network. The five antecedent factors affect strategic manufacturing effectiveness both directly or indirectly. The two key factors in the framework are hypothesised to be the attitude of top managers towards manufacturing and the involvement of manufacturing managers in setting the strategic direction of the firm. They enable the other three factors to influence strategic manufacturing effectiveness. That is plausible in the sense that without the involvement and direction of the two levels of management, it is going to be difficult, if not impossible, to create an atmosphere that lets manufacturing and other functions co-operate in such issues as strategy development and product design. Also, manufacturing managers would not be confident to take risks and be proactive to acquire new, but yet unproved, practices and technologies without having in the first place the opportunity to know the kind of competitive advantage the firm is pursuing. Such involvement will also allow manufacturing managers to emphasise more on the development of manufacturing strategy. Thus, the first two factors are the basic requirements for any strategically effective manufacturing function. Without them it is inevitable that the development of this effectiveness will be at risk.

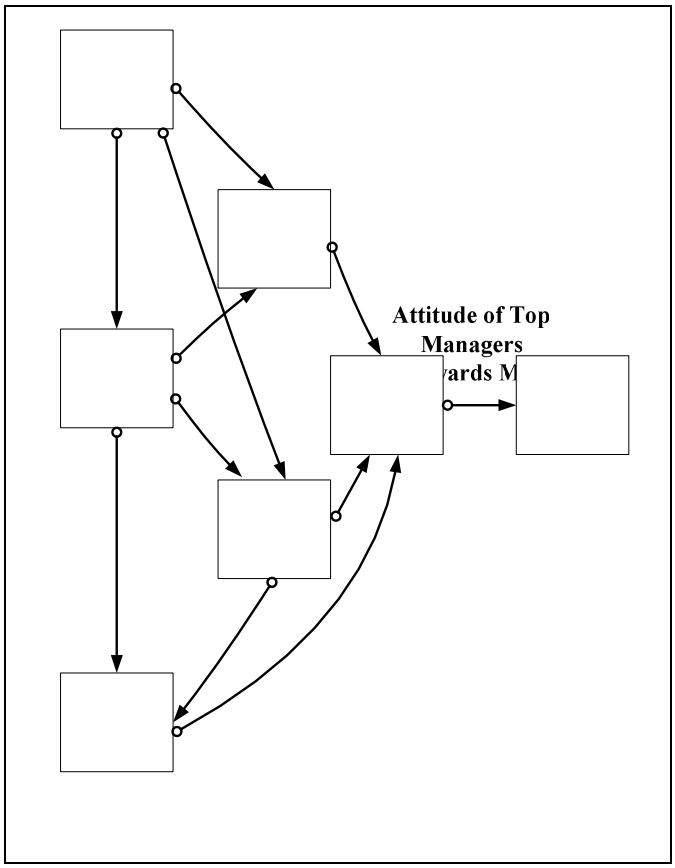

Figure 2: Conceptual Framework of Strategic Manufacturing Effectiveness

The attitude of top managers towards manufacturing can also affect the involvement of manufacturing managers in strategy debates. If top managers show interest in manufacturing, then that will encourage manufacturing managers to know more about business strategy and the type of competitive advantage it is pursuing.

Top managers can also influence the relationships between manufacturing and other functions. If they show interest in manufacturing, then it is very conceivable that they will encourage it to communicate with other functions on such matters as the development of strategy and product development.

Also, the involvement of manufacturing managers in setting business strategy, which is the other key variable, is very important in the sense that it allows the managers to know exactly what is required of manufacturing as a function in its contributions towards the execution of business strategy. That necessitates that manufacturing managers take a leading role in the efforts of co-ordination between manufacturing and other functions.

Likewise, if top managers show interest in manufacturing and the manufacturing managers are involved in business strategy development, then it is inevitable that they must formulate a functional strategy for manufacturing.

The breadth and depth of knowledge gained from the involvement in business strategy development will also lead manufacturing managers to be more proactive in their methods of acquiring new technologies and manufacturing practices even before their importance is fully apparent. Moreover, the emphasis on formulating manufacturing strategy can contribute to the proactiveness of manufacturing.

Directions for Future Research

This research is a step in the development of a more complex model that explicitly defines factors of strategic manufacturing effectiveness in a theoretical network. It has attempted to identify and opertionalise the key factors and how they interrelate. Future research could take this framework and put it through empirical validation. Future research could also identify if there are additional variables that need to be included in the framework.

Another area of further research has to do with manufacturing improvement programmes. Laugen et al. (2005) pointed out that "the field is rather scattered with many articles focusing on one or a limited set of new practices, while the reasons why these practices are considered best are often not accounted for… Why these practices, not others, and whether the authors regard the set as comprehensive remains unclear."

Examination of the constituents of manufacturing competence has not been the major focus of this study. Future research could conceptualise a better representation of manufacturing competence by including not only how much has been achieved at a certain point in time, but also how prepared a firm is to achieve the targeted performance, and how competitors are catching up. This is analogous to a race where a participant has to worry not only about how well he or she is doing at a particular moment, but also how difficult it is to finish the remaining distance, and how competitors are catching up.

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