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### **Factors Affecting the Strategic Role of Manufacturing: A Conceptual Framework Based on Hayes and Wheelwright Four Stage Model**

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## **Abstract**

The four-stage model was proposed by Hayes and Wheelwright (1984). It has achieved widespread acceptance, however there is little research that has examined the underlying factors of the model. This paper attempts to identify these factors, and how are they are interrelated.

Five factors were identified that affect the strategic role of manufacturing. They are the attitude of top managers towards manufacturing, the involvement of manufacturing managers in setting the strategic direction of the firm, formulating manufacturing strategy, manufacturing proactiveness and co-ordination between manufacturing and other functions

The five factors affect the strategic role of manufacturing both directly or indirectly, however the two key factors are 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 role of manufacturing.

Future research is required to test whether the factors adequately cover the domain of all possible effects of manufacturing effectiveness. Additionally, In order to verify if factors should be combined, future research could test the factors for construct validities. Further research is also needed to test the framework empirically by finding indicators that operationalise the factors.

**Keywords:** manufacturing strategy, strategic role of manufacturing strategy, manufacturing proactiveness, manufacturing effectiveness, manufacturing managers, unobservable variables and causal relationships, Hayes and Wheelwright's four stage model.

## **Introduction**

The four-stage model was proposed by Hayes and Wheelwright (1984). It describes the possible strategic roles of manufacturing within organisations. The model has achieved widespread acceptance and reached classic status (Sower et al, 1997). Its attractiveness is due to its simplicity and face validity, however as Barnes and Rowbotham (2004) have noted, "it is unclear from the published sources how an organization's operations are classified in accordance with the four-stage model". This was recognized before by Wheelwright and Hayes (1985) when they stated that "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".

Therefore, in order to look at the "balance" between the factors, it is imperative first to delineate these factors. However, from the most current review of manufacturing strategy literature (Dangayach and Deshmukh, 2001) and other subsequent research, it is evident that many authors have cited the Hayes and Wheelwright four-stage model but without deliberately isolating the main factors that are the driving force for strategic role of manufacturing and how these factors are interrelated.

## **Background**

Hayes and Wheelwright (1984) suggested that even though the strategic role of manufacturing 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.

To summarise the four stage model, firms in stage one and two can be characterised as having reactive strategies. For stage one firms, manufacturing's negative potential is minimised and neutralised so that it does not hinder efficiency and cost effectiveness. Manufacturing managers have no role to play in the strategic management of manufacturing; hence experts are called in when there are strategic decisions to be made. Manufacturing performance is monitored through internal management control systems. The ultimate objective is to ensure that manufacturing is kept flexible and reactive.

Stage two firms go beyond the steps taken by stage one firms and try to neutralise competitors for any competitive advantage they may have. This is done by following industry practices. The planning horizon for manufacturing decisions is extended to contain a single business cycle, and capital investment is seen as the principal method for achieving a competitive advantage.

For stage three firms, the responsibilities placed on manufacturing are significant in comparison with the first two stages. Manufacturing has to provide support for the firm's competitive strategy. Investments in manufacturing are screened to make sure they are consistent with the objectives of the business strategy. Any changes in the business strategy are translated into manufacturing implications. Issues related to long-term manufacturing developments and trends are methodically addressed.

The fourth stage gives manufacturing a central role in the formulation and implementation of competitive strategies. Thus, manufacturing-based competitive advantage is sought. Efforts are made to predict the potential of new manufacturing practices and technologies. The involvement of manufacturing goes beyond its traditional domain to include the participation in major marketing and engineering decisions. In order to acquire capabilities in advance of needs, stage four firms pursue long-range programs.

For an up-to-date discussion of the background of the four-stage model and a literature review of some empirical research that are based on the model, readers are referred to Barnes and Rowbotham (2004).

### ***Research Question***

With the exception of few studies (Hum and Leow, 1992; Hum and Leow, 1996; Barnes and Rowbotham, 2004), there is little follow-up research to critically examine the underlying factors of the model. Accordingly, this paper attempts to identify these factors, how they interrelate and provide some examples that demonstrate how some companies have achieved some of these underlying factors.

Two broad research questions are addressed in this paper:

1. What are those factors that Hayes and Wheelwright (1984) have stressed as key components of the strategic role of manufacturing?
2. How are these factors interrelated?

### ***Factors Affecting the Strategic Role of Manufacturing***

To address the first research question, the factors of a strategy concept can be derived in two ways (Venkatraman, 1989):

1. By specifying the factors a priori, that is developing the factors beforehand based on the conceptual perspective of the construct definition. This pre-specification of the factors is then validated statistically using data analytic methods.
2. The other way is to uncover the factors a posteriori. That is done analytically with such techniques as exploratory factor analysis. This approach is recommended when there is little or no theoretical foundation for a priori specification. However, it has two main limitations as Venkatraman (1989) pointed out. The first one is that the factors derived may be meaningless and thus studies based on this method may not be repeatable. The second limitation is that the method of data analysis used like exploratory factor analysis may take the central role in the development of the model.

The a priori method is utilised in this research because even though Hayes and Wheelwright (1984) did not make the factors that affect the strategic role of manufacturing explicit in a systematic way, they did, however, point to them when they were describing the characteristics of the four stages. These factors are the following:

## ***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'. A practical example that signifies the involvement of top managers is the empirical study carried out by Lefebvre and Lefebvre (1992) in 74 small manufacturing firms in the plastics industry. They found a positive relationship between the involvement and influence of chief executive officer (CEO) and the degree of process innovation.

Besides their attempt to minimise their involvement and dependence on manufacturing, Hayes and Wheelwright (1984) observed some negative aspects that are associated with the attitude of top managers towards manufacturing. For example, 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. Their broad and uncritical views of manufacturing lead them to consider economies of scale related to the production rate as the most important source of manufacturing efficiency, and consequently they regard resource allocation decisions as the most effective means of addressing the major strategic issues in manufacturing. In summary, they think the best way of solving a manufacturing problem is to throw money at it and hope that it will go away.

Such negative and blurred view of the importance of manufacturing in gaining competitive advantage for a firm is usually associated with companies in stage one or two of the four stages framework. In higher stages, however, manufacturing is considered as a competitive weapon, and is treated as such.

In stage three and four firms, top managers communicate frequently with manufacturing managers to understand the problems facing them and how they can be solved. Such positive attitudes of top executives can have profound consequences on the way employees perceive their roles within a company. For example, the CEO of Apogee Enterprises Inc., a manufacturer of glass, windows and related products in the US persisted on instilling pride in every employee at the company, and strived to set high performance expectations for them. In order to achieve that goal, he gave them the freedom and support to conduct their duties and he recognised and celebrated success. The managers of Apogee's various divisions were also empowered to make their own decisions. The CEO's objective was to make employees feel like owners of the company, not just workers (Brewer, 1995).

Another CEO of a major industrial supplier of aerospace systems and automotive parts commented that one of the top management's significant role is to 'coach people to win'. That involves focusing on long term development of human resources. Such a focus will guarantee the provision of best-prepared employees to his company (Tichy and Charan, 1995).

## ***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'.

In their study of the role of manufacturing, Rafii and Miller (1994) identified communication of the firm's competitive strategy to its manufacturing function as a prerequisite for the integration of manufacturing into the corporate mainstream. This communication can only be attained if the manufacturing managers are involved in strategy discussions with their superiors. Swamidass and Newell (1987), in an empirical study, used path analysis to conclude that the role of manufacturing managers in strategic decision making positively influences performance.

However, such a positive involvement of manufacturing managers is not apparent in lower stages. Hill (1993) observed that manufacturing managers view their roles as being only reactive to the demands placed on the production system. Whenever they have the chance to involve in corporate strategy debates, they do not explain manufacturing strategy issues effectively. Their involvement in corporate policy debates, very often, comes late when the decisions have already been agreed upon, so they have little chance of changing the decisions that can negatively affect manufacturing.

This lack of confidence and involvement from the part of manufacturing managers is due, among other things, to their lack of education and training. Research studies (e.g., Oakland and Sohal, 1989; FaForge and Bittel, 1983) have indicated that the usual career path for manufacturing managers starts when they leave school at the age of 16 to begin manual work on the shopfloor. They progress to become managers without the needed exposure to the essentials of operations management.

Moreover, Hayes *et al.* (1988) found that part of the reason manufacturing managers are not involved in shaping corporate policies is that 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. One method that can give manufacturing managers the opportunity to spend more time in strategic issues is through delegating some operational responsibilities to the shopfloor. This is what the director of facilities operations at G. D. Searle & Co. did. He used the time which would usually be spent on day-to-day running of operations on bolstering the pharmaceutical company's bottom line through finding ways of saving time and money for the various functions in the firm. He managed to locate areas where there is scope for savings like the introduction of an in-house networked electronic printing facility, and the monitoring of the heating, ventilating, and air-conditioning system by technicians from their homes via lap-top computers. Such programmes would not have materialised if the director of facilities operations was concentrating his time on day-to-day operational matters (McMillan, 1994).

The importance of getting manufacturing managers involved upfront in business strategy is summed up by Samson and Sohal (1993) who noted that 'manufacturing managers must become more than just implementers of engineering and marketing instructions on the shopfloor. Raising the status of the manufacturing function involves getting the manufacturing manager involved in the business development/market competitiveness debate. Manufacturing managers need to be interfaced with and have an understanding of the firm's customers' (p. 220).

### **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).

The importance and significance of developing manufacturing strategy is illustrated by Firestone New Zealand Ltd. When the tyres industry was deregulated, Firestone NZ found itself faced with increased competition from cheap imported tyres. To survive, the company had to re-establish its market leadership through competing effectively on both quality and price. Firestone NZ managed to survive and expand through the development of a 'strategy comprising a set of well co-ordinated objectives and action programmes aimed at securing a long-term sustainable advantage over competitors' (Paul and Suresh, 1991, p. 233). This example supports the empirical studies of Maruchek *et al.* (1990) and Tunalv (1992) who found that firms which have developed manufacturing strategies are substantially more successful than firms without one.

For firms that do not have clear manufacturing strategies, they usually seek 'the help of outside experts to tackle strategic issues involving manufacturing' (Wheelwright and Hayes, 1985).

Strategy can be deliberately formulated or it can be emergent (Mintzberg, 1987). In either case, what is important is the consistency of decisions taken. This view is stressed by Hayes and Wheelwright (1984) who noted that 'It cannot be overemphasised that it is a pattern of decisions actually made, and the degree to which that pattern supports the business strategy, that constitutes a function's strategy, not what is said or written in annual reports or planning documents' (p. 30).

Similarly, Mintzberg and Waters (1982) argued that 'conceiving strategy in terms of intentions means restricting research to the study of the perceptions of what those who, it is believed, make strategy intend to. And that kind of research- of intentions devoid of behaviour- is simply not very interesting or productive' (p. 465). Their argument is that if realised strategies are viewed as 'pattern in a stream of decisions', then strategies can be regarded as consistencies in the behaviour of firms. Consistency in decisions requires that each time a decision is considered it must be scrutinised before it is implemented. Hayes and Wheelwright (1984) noted that stage three firms screen 'decisions to be sure that they are consistent with the organisation's competitive strategy'.

The importance of screening decisions to make sure that they are consistent with corporate strategy is demonstrated by Cincinnati Milacron's Plastics Injection Machinery Business plant in Batavia, Ohio (Teresko, 1994). This plant developed a strategy which called for reduced lead-times. The production department responded with redesigning its products into modules. That resulted in a production concept where products are manufactured in parallel instead of the old linear and sequential method of production. The outcome was a drastic reduction in lead-times.

The significance of screening decisions is emphasised by Wheelwright (1984) who observed that a competent manufacturing function is not ultimately one that assures the highest efficiency, or maximum productivity, but it is rather the one that aims for consistency between the requirements of the business strategy and its policies and capabilities.

Decisions concerning capital investments are probably the most important decisions that face manufacturing managers. How such decisions are considered and analysed is indicative of the way other decisions are contemplated. There are two approaches

for considering capital investments decisions. The first one is the normative approach which emphasises financial considerations alone and does not view the strategic aspects of a potential project as significant (Pirttila and Sandstrom, 1995). This approach looks at capital investment from a purely profit maximising perspective. The other approach, called the process approach, integrates behavioural considerations into the capital budgeting process. The emphasis is both on the financial outcome of an investment and how it is going to contribute to manufacturing capabilities like quality and flexibility. Hayes and Wheelwright (1984) suggested that firms in higher stages incorporate nonfinancial considerations in their capital budgeting process.

Performance measurement and analysis of the outcomes of manufacturing decisions are important, just like the analysis of the appropriateness of these decisions before they are executed. Some manufacturing firms, however, employ very detailed measurements and controls of their operating performance. In this respect, Thackray (1990) noted that one of the differences which distinguish Japanese manufacturing industries from their British counterpart is the absence of rigid control systems. Whereas British firms have a dilemma in that every improvement made has to be seen as a major step, the Japanese implement a continuous improvement philosophy through giving their people the scope and freedom to look for solutions without the strictness of control systems impeding their efforts.

#### **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).

Ward *et al.* (1994) investigated this factor and suggested that 'proactiveness is an important characteristic for identifying manufacturing functions that offer strategic benefit to the firm and those that do not' (p. 338). They operationalised manufacturing proactiveness as being caused by manufacturing involvement and capability building programmes.

One important aspect of proactiveness is seeking new opportunities related to the present operations. These new opportunities can mean acquiring technology which can have a positive effect on competitive capabilities. It can also mean finding ways to increase market presence or maintain market leadership. With respect to acquiring technology, this can usually imply the complex task of locating an entirely new technology and introducing it into manufacturing. An important issue in this process is personal relationship. So in order to expedite this process, Deere & Co. initiated since 1990 a technology acquisition programme which it called 'People Who Know' for uncovering relevant technology or even finding that piece of information that can be useful in process improvement. The benefits from this programme for Deere & Co., which culminated in acquiring a variety of technologies, have significantly surpassed the cost of having to pay for staff associated with the programme (Boardman, 1995).



With regards to increasing or maintaining market leadership, Allen Bradley's Industrial Control Group division realised that the market for its products would increase by 1700% between 1988 and 1992. This was an opportunity for it to expand its present operations. Otherwise, if it was not ready, there was a chance that other suppliers would fill the gap. Allen Bradley toured many best-in-class electronics manufacturers to help it develop its strategic response to the market expansion. It then decided to build a new facility that has helped it fulfil its goals and at the same time reduce the time-to-market shipments of new equipment by 85% (Jasany, 1992). The contribution and significance of this CIM facility, which is called EMS1 (Electronic Manufacturing Strategy), is so enormous that it was described by a senior manager at Allen Bradley as 'not a facility, but a capability' (McKenna, 1992).

Proactiveness also involves taking some risks when making decisions. Risk taking is a virtue which can take place at any level of management as well as at the shopfloor. For example, Neff (1995) suggested that there are twelve important traits for today's CEO; one of them is 'good judgement anchored by prudent risk taking'. Story (1995) noted that part of the failure of empowerment programmes is due to management not encouraging employees to take risks.

If a firm wants to become a learning organisation, according to Kline and Saunders (1995), then it has to follow ten steps; among them is rewarding risk taking. The importance of risk taking for achieving a learning organisation is similarly advocated by a roundtable discussion of industry panellists who agreed that a climate of risk-taking is necessary if employees are to learn effectively (Chief Executive, 1995). Brown (1995) postulated that there are ten 'commandments' for managing firms toward the millennium, one of which is understanding the value of risk taking. Risk taking is also an important characteristic for teams (Temme, 1995). It increases in individual members their alertness and self-awareness (Supervisory Management, 1995).

One research study (Krueger and Dickson, 1994) found that managers who believe in themselves and consider themselves competent see more opportunities and take more risks. The reverse is true for non-competent managers. Motorola Inc. managed to challenge its Japanese competitors by its aggressiveness and risk taking approach. That emphasis was stated by the chairman of Motorola who believed that the key to success depends on manufacturing firms' readiness to take major risks (Murray, 1989).

A proactive manufacturing function must also, as Hayes and Wheelwright (1984) indicated, forecast the potential of new practices and technologies and try to obtain them even before their significances are clear.

An example of firms anticipating the potential of new technology is Toshiba, the Japanese electronics goods manufacturer, whose managers 'target market opportunities and generate product specifications that draw initially upon emerging or even non-existent technology' (Herbert, 1989).

## ***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)

One aspect of co-ordination between manufacturing and other function is the interactive development of business, manufacturing, and other functional strategies. Such a co-ordination can become the difference between the survival and demise of a firm. Storage Technology Corporation in Louisville, Colorado is a manufacturer of information storage and retrieval subsystems for high-end computer systems. It went into Chapter 11 [protection of bankrupt companies from creditors in the US during their attempt to restructure] in the mid 1980s. It then decided to form a cross-functional team to formulate cohesive corporate strategy. The team managed to get the involvement and commitment of top managers which consequently helped it to emerge from bankruptcy quickly (Stratton, 1991).

Another aspect of a co-ordinated effort between manufacturing and other functions is the continuous interaction among these functions to facilitate product design, field service, and sales training. 3M's life-sciences complex in St. Paul, Minnesota is an example of the interaction between manufacturing and other functions to help a firm in its product design. 3M produces thousands of various products from abrasives to image processing systems. At one point, most of the companies it used to supply were deep in recession. However, being a leader in its markets, 3M recession strategy was to carry on doing what it does best, that is innovating and designing new products. To achieve that goal, it decided to form cross-functional teams from manufacturing and other departments which managed to clear the obstacles in the way of the flow of technology around the company and thus enhanced innovation and product design (Economist, 1991).

Co-ordination between manufacturing and other functions can also be set up for the purpose of transferring 'know-how' among the functions. However, transfer of know how can also take place within various manufacturing departments in large and diversified firms. For example, one of the duties of the corporate director of manufacturing systems in Motorola Inc. was to act as a matchmaker between various departments and groups that needed a particular technology and others that could provide it (Horwitt, 1990).

Another example of within-function co-ordination is Bibby Sterilin Ltd., a British manufacturer of health care products which focused its manufacturing by five product groups. Each product group was assigned a team to develop a strategy relevant for its product portfolio. Afterwards, in order to promote communication and co-ordination, the teams were brought together to allow for cross-fertilisation of ideas among them. The co-ordination among the teams resulted in the agreement on common issues such as the necessity of product strategy to precede automation decisions and the need for consistency between short-term decisions and long-term plans (Bodnar and Harrison, 1991).

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).

Honda of America Manufacturing Inc. is an example of a firm which considers suppliers as strategic to the success of its business because 80% of the cost of a Honda automobile is purchased from outside suppliers. For that reason, Honda strives to develop its suppliers and make them adopt its systematic approach of reducing costs, increasing quality, and developing leading-edge technology (Fitzgerald, 1995).

## ***How the Factors are Interrelated***

To address the second research question, a conceptual framework is developed which shows how the factors are interrelated. A conceptual framework is a theoretical model that attempts to explain real-world phenomena by expressed relationships among concepts (Blalock, 1969). The concepts, or factors as they are called in this paper, are in themselves not observable but are latent in the phenomenon under study (Straub, 1989). So, before addressing the second research question, two theoretical considerations which have implications on the framework are first discussed. These are the use of unobservable variables, and the utilisation of causal analysis to represent relationships between concepts.

## ***Unobservable Variables***

The nature and applicability of unobservable [or latent] variables have been scrutinised in many disciplines, but none more so than in the literature of the philosophy of science which has witnessed fierce debates concerned with this issue (Boyd, 1991). Most of these debates are between two schools of thought; the logical positivists and the realists. The logical positivists contend that one can never be certain of the existence of unobservables. Thus, according to this school of thought, 'theories that contain unobservables should not be judged on the basis of their correspondence to reality, but instead on their instrumental value as tools for generating predictions about the behaviour of physical, natural, and social systems' (Godfrey and Hill, 1995, p. 520).

The opposing school of thought, represented by the realists, argues that knowledge gained from scientific endeavours can point to the existence of unobservable entities. The argument used by the realists is that 'when a theory that contains unobservable entities is well corroborated by scientific evidence, then we may have good reason for believing that those unobservable entities have a correspondence in reality. Thus...we can make statements about the truth value of theories that contain unobservables' (Godfrey and Hill, 1995, p. 520).

These debates between the logical positivists and the realists have significant implications for strategy research because most of the theories that are addressed in strategic management contain concepts that are unobservables.

The logical positivists have been criticized because of their inability to explain such theories as quantum physics which are based on unobservable entities. Thus the views of the realist position is adopted in this research, because this school of thought argues, according to Godfrey and Hill (1995), that 'since our theories can give us knowledge about unobservables, it is legitimate to derive normative rules from those theories that can be used to guide managerial action' (p. 520).

## ***Causal Relationships***

The second theoretical consideration, which is an extension of the first one, is the assumption of causal relationships in models involving unobservable variables. Causality has been debated in many disciplines. However, there is no consensus on its meaning and nature. Bollen (1989) argues that there are three components or conditions for causality. They are isolation, association, and the direction of influence.

If, for example, there is a cause and effect relationship between two variables such that x is a cause and y is an effect, then isolation means all the effects on y are due to x alone. That implies y is totally isolated from being affected by other variables. Association between two variables like x and y means that they covary and correlate with one another. The last condition for causality is knowing the direction of influence. That is x influences y and not vice versa.

About these three conditions for causality, namely isolation, association, and direction of influence, Bollen (1989) noted that 'each condition is difficult to meet, but it is perhaps impossible to be certain that a cause and an effect are isolated from all other influences. We must regard all models as approximations to reality' (p. 79).

The concerns introduced by using latent concepts in a theoretical network, by implying causality, does not stop with what has already been pointed out. The critical issue is that whatever statistical analyses are used to test a model, it can never be proven. The reason behind this as Bagozzi and Phillips (1982) pointed out is that 'because the non-observational hypotheses of a theory are not restricted to particular space or time locations, the number of times a particular effect could be observed is potentially infinite. As a result, no matter how many positive observations are obtained in support of a theory, the certainty of the theory is still in doubt' (p. 467).

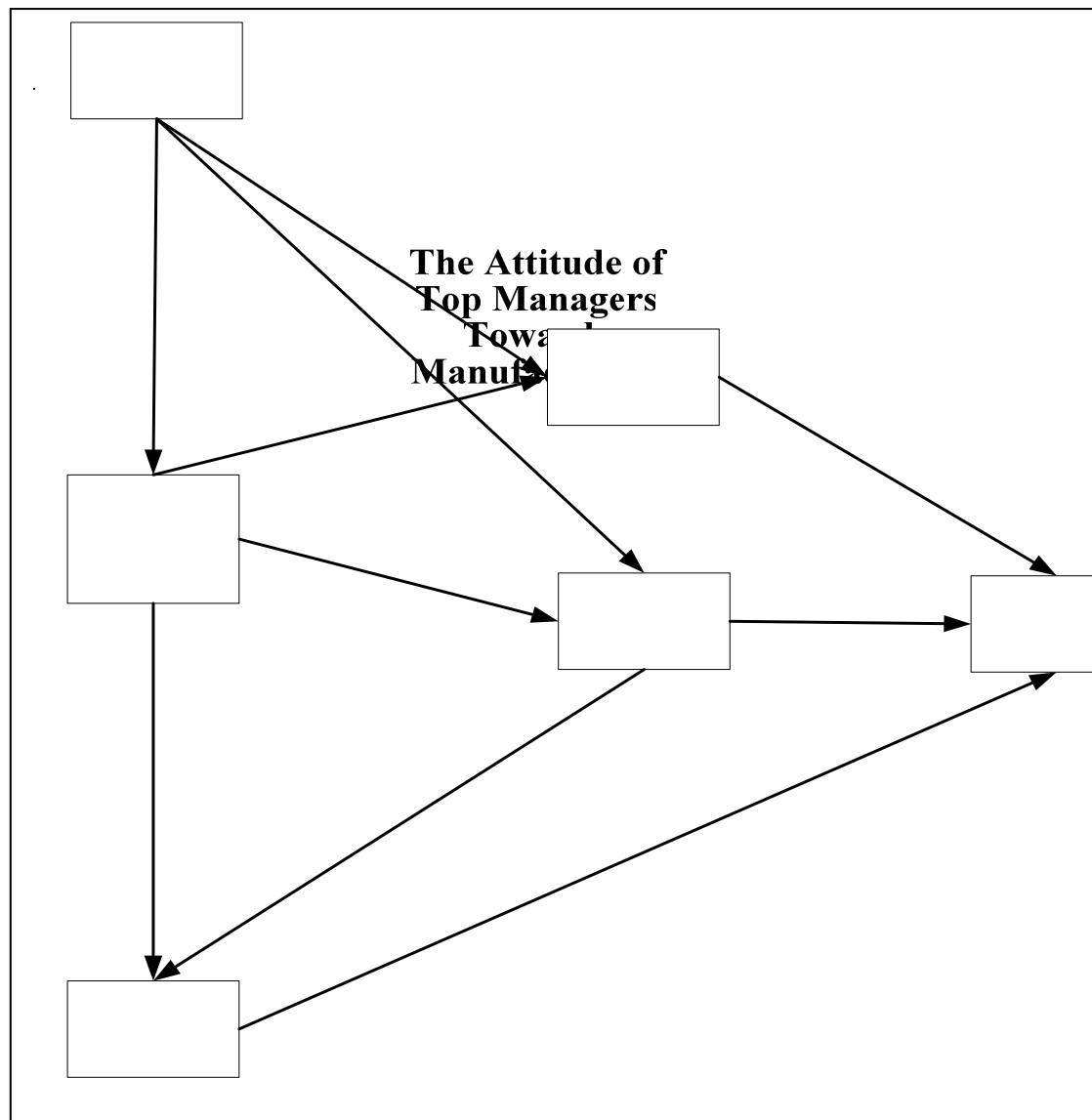
That is why the only way to accept a theory tentatively is to subject it to rigorous tests repeatedly until it has accumulated enough evidence for its support or it is superseded by better theories. There is obviously a need for a tradition, in manufacturing strategy, of building theories in a cumulative basis.

### ***Conceptual Framework of the Strategic Role of Manufacturing***

The brief discussion of latent variables and causal relationships is utilised to construct the conceptual framework of the strategic role of manufacturing.

It can be observed, from Figure 1, that the five factors affect the strategic role of manufacturing both directly or indirectly. The two key factors in the framework are 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 role of manufacturing. That is because without the involvement and direction of the two levels of management, it is 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 cannot 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 1:** The Conceptual framework showing interrelationships amongst factors affecting the strategic role of manufacturing



**Involvement of Manufacturing Managers in**

**Setting the Strategic Direction of the Firm**

The attitude of top managers towards manufacturing can also affect the involvement of manufacturing managers. 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 in 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.

### ***Discussion and Recommendations for Further Research***

This paper represents an attempt to delineate the factors that affect the strategic role of manufacturing as emerged from the work of Hayes and Wheelwright (1984). It is worth pointing out that with respect to the a priori specification of these factors, there are two points to be made which are concerned with comprehensiveness and parsimony. The first point is whether these factors adequately cover the domain of all possible effects of manufacturing effectiveness. The second point is whether they are distinct from one another.

Regarding the first point, even though one cannot argue that these factors cover all the possible antecedents that can affect the strategic role of manufacturing, it is contended here that the five factors derived represent the important themes associated with manufacturing's role in gaining a competitive advantage for a firm. They have been stressed in various contexts in the literature as being significant in upgrading manufacturing effectiveness. However, Future research could examine the factors critically and extend the framework to include other factors if necessary.

As for the second point regarding the distinctiveness of the five factors, it can be argued, for example, that two of the factors, namely, (1) the attitude of top managers towards manufacturing, and (2) the involvement of manufacturing managers in setting the strategic direction of the firm, represent two aspects of the same underlying factor which can be called 'communication between manufacturing and top management'. However, the literature of manufacturing strategy does not provide convincing arguments that would suggest combining such factors.

Thus all factors are delineated individually at this stage. In order to verify if factors should be combined, future research could test the factors for two types of construct validities, namely convergent and discriminant validities. These tests should provide support if the dimensions are distinct or if they converge towards one another and therefore should be combined.

Further research is needed to test the framework empirically by finding indicators that operationalise the factors.

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