

## ORGANISATIONAL MANAGEMENT AND R&D ACTIVITIES IN SMEs?

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This article is concerned with the correlation of organisation management and its business performance in manufacturing SMEs, and tested by two main aspects: organisational management and R&D activity. The relationships were tested with questionnaire data from a random sample of 189 firms. Results from statistics on the issue showed that if manufacturing SMEs wish to give a higher priority to R&D activities, their managerial strategies must not only be focused on their governmental policies or economic indices but also consider their social responsibility to the community or relevant socio-economic or political pressures on the R&D sector etc. On the other hand, if those firms desire that their new product development programs or new technological developments are to be more successful, they have to focus their managerial strategies on the establishment of secure financial resources, good current profitability or flexible manpower structures etc.

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### I. INTRODUCTION

Economically the small and medium sized enterprises (SMEs) is an important asset within all economic areas including advanced industrial economies. Though the actions of a SME may have little effect on society, when all SMEs are grouped together, their impact is major (Steinhoff and Burgess, 1993). SMEs on behalf of own advantages over the limit of their size need to be perceived as investing in the community. Solving societal problems could enhance the image of the SME even though the effects of

these efforts may not be measured directly in bottom line profits (Kuriloff et al., 1993).

Socially the SME fulfills a number of important functions in an industrial society by creating career opportunities. Robinson and Pearce (1984) suggest that although SMEs' strategic planning has been characterised as informal, unstructured, irregular, and uncomprehensive, a short-term, informal approach may be appropriate given the unique problems and situations facing SMEs. Many SME owners are seeking and identifying sources to assist in the successful management of their business. However they are occasionally held back by mana-

gerial and entrepreneurial limitations, in both innovation and ability.

Recent articles (Glunk and Wilderom, 1998; Hatton and Raymond, 1994; Morton, 1995) in the management literature suggest that an organisation will be more effective if certain factors are congruent or match each other. They highlights several variables that influence organisational performance in SMEs, which include a fit between strategy and technology, structure and technology, and the environment, industry and strategy. According to Morton (1995), one of the tasks facing organisations is to maintain a balance between the external forces and the internal dimensions of the organisation. Hatton and Raymond (1994), in a research model for SMEs, state that the systems of congruence as organisational effectiveness is the most well enhanced if all variables of the organisation and its environment fit perfectly. In the study, they argued a firm is most effective if all six organisational variables, i.e. environment, strategy, task, technology, organisational design, and the individual, are simultaneously congruent

This research presented in this paper is concerned with the relationship between organisational management and research & development in SMEs in the manufacturing sector. This is achieved through an inferential analysis of SMEs that were judged to have had R&D experience. The intention

is to develop suggestions for how SMEs can undertake organisational innovation efficiently and thereby achieve increased operational quality with decreased management costs. Also, implication for management and research limitations is explained in the discussion and conclusions section.

## II. THEORETICAL FOUNDATIONS

### Consideration of Economic Trends vs. Priority of R&D Sector

Research and Development (R&D) has made significant contributions to the vitality of the SME community as well as the economy as a whole. Raymond et al. (1996), however, argue that there is no 'one best' strategy of technological change for SMEs. This is due to the inherent complexity and heterogeneity of the SME universe, and to the large number of factors that potentially affect the adoption of a new technology, or the progress of a technological development (Birnbaum, 1985).

According to Kantrow (1980), OECD (1992), and Miller (1995), the monitoring of economic trends can reveal a great deal to a firm with respect to R&D activities, such as future plans, cost changes, and new wage demands etc. Salomon (1984) also insists

that technical innovation stems from within the economic and social system and is not merely an adjustment to transformations brought about by causes outside that system. The monitoring of economic trends can reveal a great deal to a firm with respect to R&D activities, for example, future plans, cost changes, and new wage demands etc. So deep insights are required, i.e. how might economic projection affect those things at all? how might any technological developments threaten the firm or assist it? These questions might especially be valid for manufacturing SMEs that can sometimes pick up one or two percentage points of market share and thus double or triple their sales when major competitors are affected negatively.

Not only have changes in the international environment been encouraging deeper R&D competition but also transitions of economic and industrial structure need an increasing role in terms of R&D, the emergence of new high technology industries, and further quality growth in existing industrial sectors. Sometimes R&D activities themselves also are, particularly in developing countries, driven to strong government-supported initiatives on a series of policies. Accordingly having concerns about any changes of economic trend or governmental policy must naturally be influential in terms of the level of R&D priority of any manufacturing SME

involved. Because those manufacturing SMEs believe that following such trends or policies could bring structural strengths in terms of R&D systems within their firms. They decide their own priority in relation to R&D activities by considering the feasibility of future plans based on several governmental policies or economic indices. There, it is hypothesised that:

**Hypothesis 1** Consideration of economic trends in a manufacturing SME is likely to correlate with the priority of the R&D sector within the organisation.

#### Financial Conditions vs. Success of New Product Development

Having considered ways of achieving access to sources regarding available funds or financial support, and obtaining regular information about competitors' financial status, it might be natural that those firms are likely to have even more successful results in proceeding with any new product developments within the organisation. Specifically this happens because of: the promoting of technology development through various financial sources', for example, governmental policy funds, investment or loans via venture capital, loans from related banks, and financial support from big firms are all valuable sources which is a critical

influence for R&D sectors by keeping a condition of current internal profitability.

According to Himmelberg and Petersen (1994), internal finance is an important determinant of R&D investment. Schmitt (1995) argues that the success of corporate-level R&D depends on: a sufficiently high proportion of corporate funding to permit the centralised laboratory to define its own programs. Product development planning must include an R&D financial plan, examining affordability, as well and the distribution of total funds among basic research, applied research, advanced development, and product development (Chamers et al., 1985). Moreover, according to Chambers et al. (1985), the major business factors relevant to selecting projects and allocating resources are: the financial implications of each product such as revenues, costs, profits, cash flows, and investments, the interactions of projects in the R&D portfolio, the effect of timing on product placements, pricing, market, and position. Langley and Truax (1994) argue that in a process of new technology adoption in SMEs obtaining financing is critical in most firms since the investments involved are major. This is always met at least in part from an external source e.g. government subsidy or loan programme, venture capital or bank loan. Occasionally, the minimum size of R&D investment required is too great for the

financing resources of individual firms (OECD, 1995).

**Hypothesis 2** Keeping reliable financial conditions in manufacturing SMEs is likely to orrelate with the success of new product development.

#### Community Expectations vs. Priority of R&D Sector

Raymond et al. (1996), emphasising the difficulty in clearly identifying an ideal strategy of technological change for manufacturing SMEs, argues two main determinants of the decision to adopt a new technology or proceed to a technological development: socio-economic pressures and the reaction of the firm to these pressures, their technological competencies and the technological culture.

The demand pull aspect emphasise that the priority given to R&D endeavours has to be decided according to socio-economic demand. This approach has stressed social or economic value and the importance of technology development activity, and also shown why co-operative research between industry, academia, and research institute must be encouraged as long as necessary. Many environments surrounding R&D activities are changing beyond or together with the development of industrial technology

and as a result social or national contributions by developed technologies have become an important issue. Manufacturing SMEs are not exempt from this process. Indeed it is true that manufacturing SMEs are much involved in community affairs or expectations are prone to be outside oriented in operating their business and organisation. These types of firms are more swiftly obliged to adapt to any desire or even socio-economic or political pressures from the community in which they are situated.

According to Schoman et al. (1969), as a result of the increase of general perception regarding the socio-technological interface, past methods of R&D resource allocation by intuition, consensus, prejudice, and other factors generally described as political may not be satisfactory in the future. It is now apparent that technological change is closely associated with not only economic but also social, legal and cultural changes whose interaction is complex (OECD, 1988). Transformations in society and technology are at the same time cause and effect. In this sense, technology can be defined as a social process which by meeting real or imagined needs changes those needs just as it is changed by them. In brief, long-term growth should be viewed as a process of matching technologies with social needs (OECD, 1988). Socio-economic pressures and the re-

action of the firm to these pressures, according to Raymond et al. (1996), constitute the main determinants of the decision to adopt a new technology or proceed to a technological development. Technologies have now become both more noticeable because of their repercussions and more open because of the public money invested in them. Public opinion is now more aware of government influence on the direction of national R&D efforts, and of the role government can play in regulating technical change (OECD, 1988). Socio-political pressures to develop alternative technologies are almost identical (Miller, 1995). Since technological innovation is an evolutionary process whose effects are subject to the approval of society at large, governments need to deal with questions relating to the broader societal integration of technological development.

Economic considerations alone are no longer sufficient for the complex calculation of social costs and benefits (OECD, 1988). So R&D becomes a strategic defence against socio-political and technical risks (Miller, 1995). The socio-ecological environment of SMEs includes the neighbourhoods and communities in which the firm operates together with the culture, social modes, and ethical value systems as well as the natural surroundings (Alexander, 1983). The need to speed up various developments and make environmental issues into a

priority area of public R&D funding is particularly evident in relation to the risks, but also the uncertainties associated with emerging environmental threats, notably the issues of ozone depletion and global warming (OECD, 1992).

**Hypothesis 3** A strategy of manufacturing SMEs that matches community expectations is likely to affect the priority of the R&D sector in an organisation.

#### Management Goal vs. Success of New Product Development

Manufacturing SMEs which not only had objectives well set by top management, but also had firm goals for the next years that the firm aimed to achieve reveals that most new product development programs in their firms during the planned years were successful. This is because a problem common to most strategic planning is the contradiction between management's stated goals and its actual direction. In particular, this conclusion may be attributable: the possibility of being more successful in terms of new product developments owing to achievable and attainable corporate goals; the synergy effect towards the R&D results which are integrated with the objectives of other functions in the firm; establishing feasible continuous R&D goals through

accumulating the know-how of management by objective.

According to Chambers et al. (1985), the firm and R&D aspect must be coupled in such a way that both become more creative, which include that R&D planning must be conducted interactively with total strategic planning in a firm. Schmitt (1985) suggests that the success of corporate-level R&D depends on: a thorough understanding of corporate goals and strategies to guide a balanced program among various businesses, and also there are several pre-eminent reasons for undertaking corporate R&D in the first place: synergy, interdisciplinary focus, and lead time. It is as sub-objectives of the business unit objectives that the major proportion of R&D objectives should make their contribution to the corporate whole and be integrated with the objectives of other functions (Wilkinson, 1987). Accordingly, not only the management of R&D should be contributing to the definition of the objectives of all other functions in an organisation (Wilkinson, 1987), but also R&D personnel must understand and agree with the purpose inherent in their jobs if they are to be both productive and high spirited (Schmitt, 1985). Therefore,

**Hypothesis 4** Management goals set by a manufacturing SME are likely to correlate

with the success of new product development.

### Adequate Labour Force vs. Success of New Product Development

A firm which has dedicated itself to even more systematic human resource management can bring maximisation of effect by utilising as well as replacing manpower within the organisation according to its necessity. The development of R&D manpower is normally accomplished by four areas: the first is generating sufficiently qualified manpower by general theoretical learning or specific functional training, the second is its placement by proper ability and potential, and third and fourth is including its utilisation and maintenance, respectively. The former involves co-operative labour relations, the rationalisation of management, and development of new jobs or functions, the latter relates to health, safety, pay, or time management and supervision. Through processes like these, manufacturing SMEs can maximise their performance by distributing effectively or using reasonably limited R&D resources within their organisation. This makes it possible for firms to have more flexible adaptations against technical changes owing to accumulated experiences in relation to human resource management. Also not only cutting

off the costs of acquiring manpower away from other labour markets increases R&D productivity, but also in some instances some human resources have an important meaning in having an intangible unlimited potential beyond any physical value in defining a technological level or effect in a manufacturing SME.

According to Chambers et al. (1985), in order to achieve successful product development planning must make an R&D administrative plan, with requirements for manpower, skills mix, and facilities. Bosworth (1989) insists that the growth of the SME, including its R&D sector, almost certainly implies a transition from the use of external labour markets to internal labour markets. As an instance, labour-saving technical change is induced by a relative increase in wages; but if real wages go down, a substitution effect occurs and, in addition, labour-intensive technical change is stimulated (Vivarelli, 1995). Meanwhile, Shimada (1991) suggests that all technology becomes at last a meaningful concept only after the role of human resources, and the conventional and narrow sense of technology as "humanware" is considered.

**Hypothesis 5** Keeping an adequate labour force in a manufacturing SME is likely to affect the success of new product development.

### III. METHODS

#### Sample

A questionnaire was designed and a pilot survey was carried out to refine and enhance its reliability. 100 manufacturing SMEs in the UK were randomly selected to survey (KOMPASS, 1995). The questionnaires were sent to production managers by post, and a follow-up letter was sent to them two weeks after the first mailing. The production managers, all of whom were working in the manufacturing area at the time of the survey, were chosen, since they would be in a good position to judge the organisation management elements related to manufacturing SMEs

A total of 25 firms responded to the survey, and 21 of these qualified for the analysis. The questionnaires were used for checking which variables were irrelevant, duplicated, or obscure. Several interviews were also carried out to validate the questionnaire. Some academic staff were consulted about the questionnaire. They were asked to elaborate on any additional factors if needed and identify any problems with the questions. On the basis of suggestions by both survey and interview, a few changes were made to the wording of most questions except for two of them.

After the pilot survey stated above, a five-page questionnaire was prepared with the measures based on the related literature and was sent to manufacturing SMEs randomly selected from within the precision industry which were thought to employ fewer than 500 workers (Stanworth and Gray, 1991). They were equally sent to production managers in 1000 firms. Production managers were selected as they would have more experience with higher career development in general as well as specific knowledge of their skilled manufacturing SME area. A covering letter explaining the purpose of the study and a self addressed and stamped envelope accompanied the questionnaire. Three weeks after this, a follow-up letter, the questionnaire, and a stamped return envelope was sent to the non-respondents. Responses were received from 195 subjects, a response rate of above 20 percent. Out of this, 6 were not completed because the subjects had left their jobs. Consequently, a total of 189 questionnaires qualified for the empirical analysis.

The firms were all from the precision equipment industry including measuring, testing, and medical and surgical equipment etc.

## Measures

For this study, the aspect of organisational management was assessed in eight categories taken from a series of items suggested by Greiner and Metzger (1983) and Chambers et al. (1985). The seven categories are as follows: *Economic trends*- The monitoring of economic trends can reveal a great deal to a firm with respect to its future production plans, realistic inventory levels and price changes. *Financial conditions*- No business would be competitive without an exact review of the financial status of the firm, its financial needs, and the inevitable financial conflict. *Development of business/services*- Every firm is different in its growth pattern and its vulnerability to new competition. *Community expectations*- A firm's relationship with its surrounding community has been very important in terms of labour supply, living conditions, and revenue contributions from the firm. *Competitive position*- Many firms ignore their competition when business is good, only to wake up one day to realise that they have been overtaken. *Legislative adaptation*- Every firm must be alert continually to regional or national regulations governing its business. *Management goals*- A problem common to most strategic planning in a firm is the contradiction between management's stated goals and its

actual performance. *Labour force*- The labour size in management must be analysed carefully and regularly to be consistent with the firm's objectives.

In the meantime, experienced researchers and practitioners suggest that identifying a single, all encompassing, measure of R&D activities is difficult. Accordingly, here are used several measures as well. This study has obtained data through four areas, that is 1) success of new product development, 2) control of product development process, 3) priority of R&D sector, and 4) impact of technological development (Rinholm and Boag, 1987; Dowling and McGee, 1994). There are defined as follows: *Success of new product development* measures whether new product development programs were successful during the past 5 years. *Control of product development process* measures whether the process of controlling new product development over the past 5 years has been satisfactory. *Priority of R&D sector* refers to how a higher priority is given to R&D activities within the firm compared to others such as marketing, production etc. *Impact of technological development* confirms whether new technological developments have an impact on the growth of each firm.

First, the strategies of SMEs in terms of organisation management were to be measured. Respondents were asked to express

their evaluation or each item's practice according to their current mode of operation. The respondents were asked to indicate on a 5-point Likert-type scale, ranging from "strongly disagree" to "strongly agree," the degree of involvement their firm applies to each of the eight strategy performance criteria. Second, the four categories of R&D activities, which include perception, satisfaction, or state, were measured along with the additional sub items. For a measure of intensiveness, subjects were asked to indicate on a 5-point Likert scale the extent to which each specific question is perceived or evaluated related to R&D activities in their firm. Ratio and nominal scales were also used together to drive them into more exact responses. Each score represented an amount of implementation, or output in the related activities.

#### Validity

Internal consistency of the four variables was investigated using the "Reliability Analysis" procedure. The "Alpha" model, as the basic formula for determining internal consistency, was applied for each dimension. Taking the minimum proposed level of 0.60-0.70 for Alpha, both of the two variables were well above 0.70, indicating that all scales are reliable. Accordingly, there

was no need to delete dimensions with an Alpha value under 0.60. In conclusion, this high coefficient alpha value indicates a high degree of internal consistency of the instrument, and a high degree of internal consistency also supports the reliability of individual measures.

Also, "content validity" was evaluated non-numerically. The results showed that the two variables of the critical factors of organisation management in SMEs developed in this study have content validity since the selection of measurement items was based on both an exhaustive review of the literature and detailed evaluations by academicians and practising managers. Furthermore, the pre-test subjects indicated that the content of each factor was well represented by the measurement items employed.

## IV. RESULTS

This analysis was carried out to see the relationship between major variables to make any suggestions for advancing the performance of the organisation management in the SME sector. As the related variables organisational management, i.e. economic trends, management goals, financial conditions and labour force etc. and

R&D activities, i.e. success of new product development or priority of R&D activities etc. were chosen. It was forecasted that most items of organisational management would have significant coefficient values for all items of R&D activities. In particular, even more salient items among them should be 'success of new product development' and 'priority of R&D activities'. However, from a theoretical point of view, there could exist some misgivings in applying such aspects to manufacturing SMEs. For instance, an item of organisational management such as community expectations might be regarded as unrelated to the R&D activities of the firms themselves, which are often independent of profit issues. At any rate, the inferential approach expected statistically significant results towards five research hypotheses.

#### The Statistical Results of Each Hypothesis

Table 1 shows that many items in organisational management, i.e. economic trends, community expectations, and labour force etc. correlate significantly not only with the perception of the success of new product development and higher priority of R&D activity or the impact of technological development, but also with the satisfaction of the process of new product development.

This means that major R&D sectors in SMEs have interactive relationships with diverse aspects of managerial strategies which emphasise that firms must place their concerns more into such strategies in order to promote their R&D activities. To be specific, consideration of economic trends and community expectations are likely due to the higher priority given to the R&D sector, the control of the process of new product development, and the impact of new technological development, whereas financial conditions, management goals, and adequate labour force are apt to be more relevant to the success of new product development in SMEs. All results presented here are considered to be reliable as the basic approach of the analysis was made through thorough validation steps of the measures.

As shown in the results of Table 1, of the many relationships with items of organisational management, especially two columns hypothesised, i.e. the success of new product development and priority of R&D activities have shown higher correlations providing more sufficient explanatory power on the criteria of statistics. The items reveal quite significant values as each  $r$  shows a value of  $> 0.3$ . This means that attempting an inferential explanation using such results is meaningful, in short it provides a means of defining relationships

between organisational management and R&D activities in manufacturing SMEs.

The 'consideration of economic trends' and 'community expectations' which are externally oriented items are related to 'the priority of R&D sector', whereas the others with internally oriented items are relevant to 'the success of new product development'. Greiner and Metzger (1983) state; legislative, economic, business, competitive, and community, five of these areas represent a broad scan of the firm's external environment in organisational management, whereas goal, labour, and financial deal with the internal strengths and weaknesses of the firm. In summary, all the result of the correlation analyses strongly confirmed each proposition.

The result of hypothesis 1 showed that the relationship between the two items has a higher coefficient value than others in the row. Therefore this hypothesis, H1, is strongly borne out which indicates that manufacturing SMEs which concern themselves more with the effect of recent economic trends, or forecast future economic situations tend to put a higher priority on their R&D sector within the organisation. Manufacturing SMEs which concern themselves with how recent economic trends have impacted on their business, or about the ability to forecast the economy over the next few years, show they tend not only to give their related R&D sector higher priority to promote them within the firm compared to others such as marketing, production etc. but also sometimes satisfied

Table 1. Pearson Correlations between Organisational Management and R&D Activities

Item	Success of new product development	Control of Product development process	Priority of R&D sector	Impact of Technological development
Consideration of economic trends	.14	.25***	.31***	.19***
Financial conditions	.31***	.13	.08	.14
Development of business/ services	.21***	.01	.01	.18
Community expectations	.15	.28***	.35***	.19***
Competitive position	.22***	.22	.18	.11
Adaptation for legislation changes	.22***	.16	.13	.07
Management goals	.37***	.24***	.04	.08
Adequate labour force	.38***	.19	.17	.14

\*\*\* Significant at the  $p < .01$  level

about the process of controlling new product development over recent years. The above result might be attributed to the following reasons: opportunity of future plans relevant to R&D through governmental policies or economic indices, more exact judgement concerning size of investment of R&D through the trend of cost changes etc., and establishing planning that is more realistic in relation to R&D manpower by forecasting new wage demands and other employment-related issues.

Also the result confirmed the hypothesis 2. The two items revealed a statistically significant relationship in their coefficient value. This means that manufacturing SMEs which regularly analyse current profitability against competitors, or have good relationships with their banks or financial supporters, are likely to be successful in implementing their new product development programs.

The more stable the finance, the more successful are in the R&D activities. This is because many manufacturing SMEs have suffered from problems such as transactional procedures, mortgage conditions, loan period, use scope, financial allocation, and rate of interest in the difficulties they face in utilising technology finance in relationships with their financial supporters, including banks. Accordingly, keeping better relationships with financial supporters can

guarantee even more firm possibilities in the preparation and distribution of money needed for related technological development and investment. Technological development finance can specifically be accomplished by an R&D subsidy, a direct investment such as venture capital, loans, and or guarantee based on related regulations. In having these support mechanism, many manufacturing SMEs can create demand for technology development finance, that enables them to proceed with planned R&D investment, to employ the required R&D manpower, and importantly introduce essential outside technology.

Hypothesis 3 produced a higher degree of correlation between the two items as well. It was hypothesised that the responses towards community expectations in SMEs would be influential: that it would affect any firm's level of R&D activities to the extent of its implementation. This means that manufacturing SMEs which involve themselves more positively in community concerns or expectations, or are willing to commit resources in the future to the public sector placed a higher R&D priority on the fields related to organisational development.

Today changes in society and environment in relation to R&D activities can be summarised as follows: first, increasing demands towards technological development

which can create harmony among humans, society, and nature; second, growing expectations for the role of technology development in improving public welfare; and finally the variety and level of those demands and expectations which develop over time. Accordingly the following can also be summarised as the reasons that support to hypothesis 3: acceptance of socio-economic or political pressures applied to R&D activities made sometimes within the community, in which a firm is situated; prioritising within the R&D sector as things concerning environmental issues associated with health, waste products, and recycling; increasing the interests of R&D over technological products relating to ethical issues such as biological research; and the necessity of any R&D by social, legal and cultural changes in the community.

Hypothesis 4 was also confirmed as the 'management goals' of strategic factor correlates with 'success of new product development' in manufacturing SMEs. This indicates that manufacturing SMEs which have their goals well-achieved as well as well-set are inclined to be more successful in doing their new product development activities in the firm.

In reality R&D activities take longer before a return on the investment is realised. They also have a higher risk and uncertainty level and require considerable

manpower and finance resources. Accordingly, above all for the technology intensive SMEs it is extremely critical to set their R&D goals to be better adapted for higher value-added and business diversification. These goals can then create: a productive connection between R&D personnel and production managers, success of new product development and accumulation of technological know-how through sincere working behaviour, the dividing of individual R&D work on the basis of secure responsibility, an integrated firm-wide approach towards any professional technology research, and participation of R&D manager in the process of establishing total corporate planning.

Finally, the result of hypothesis 5 showed that a relationship exists, as hypothesised, between the two items above, as suggested by Bosworth (1989) and Vivarelli (1995). The proposition indicates that manufacturing SMEs which not only keep a better current labour force but also forecast the future demand in the firm are able to be more successful in implementing the new product development programs they want. This can be explained by the following reasons: being more successful results in new product development through effective R&D human resource management in the internal manpower structure; more flexible confrontation against technical changes

through accumulated personal experiences by systematic resource management; increasing R&D productivity by cutting off the costs of attracting talent away from other labour markets; and finally the importance of the role of human resources in defining any technology itself.

### Critical Factor Deployment For Further Development

Knowledge of the organisational management of SMEs is still very limited in many areas and sometimes appears to be improper and unscientific to attempt any complex modelling without considering a method for its testing and refinement.

Accordingly whatever can be developed by applying empirical findings must be a simple and logical model free of subjective assumptions wherever if possible.

The nature of the interrelationships between the two critical factors, i.e. organisational management and R&D activities is complex, as revealed by the factor-factor correlations shown in Tables 1. Correlations greater than 0.24(Chai, 1994) for items used here are significant at the 1% level. The table lists major significant factor-factor correlations within the correlation matrix. The strongest correlations are between the two items of 'labour force' and 'success of new product development' as shown.

Figure 1 Overall Significant Correlations between Items in Variables

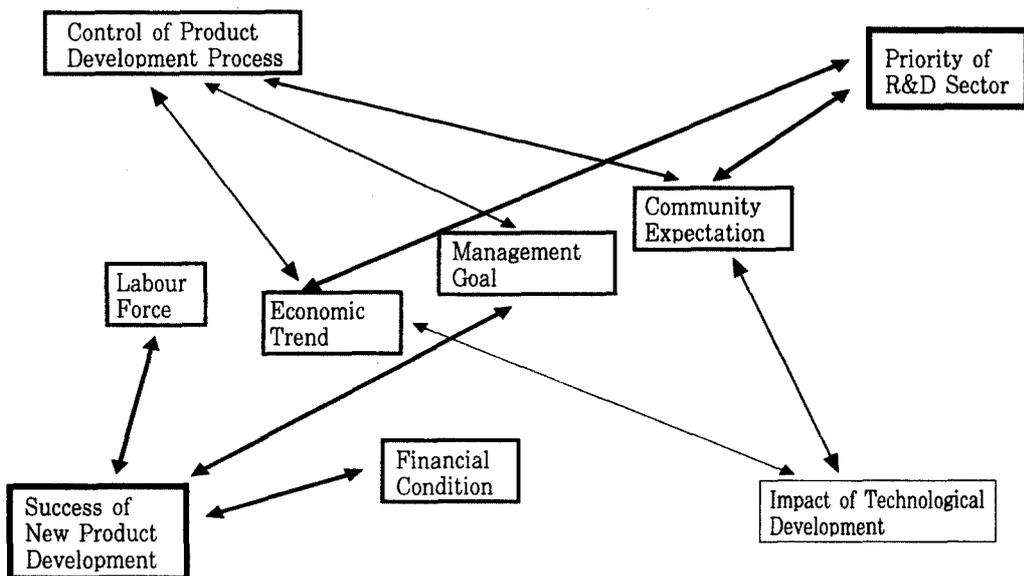


Figure 1 is a diagrammatic representation of the significant factor-factor correlations based on the major findings in sections before. Each box constructed with thicker lines indicates the major factor name related to the element of R&D activities. 'Economic trends' and 'community expectations' in the centre of the diagram all correlate with 'control of product development process' and 'priority of R&D sector'. For ease of understanding the diagram has been simplified in such a way that the relationships between 'success of new product development' and 'priority of R&D sector' which are associated with several strategic elements are linked together, and by the other interactive relationships between the factor 'control of product development process' in the top left of the diagram.

Each of these significant correlations are connected individually. Thicker lines represent stronger correlations between factors while, to help only related understanding in the bottom right of the diagram, two correlations under  $<0.24$  are symbolised by thin lines.

#### An Aggregated Approach for Organisational Management and R&D Activities of SMEs

Here as a final stage an aggregated model is developed in order to integrate the major findings obtained through the

several steps outlined before in the paper. In a word, an integrated approach for expanded application of the research results in the future is attempted. This basically becomes possible in the light of the statistical results of the five propositions demonstrated and stated in the each hypothesis. Knowledge of the aspects of organisation management generated by the comprehensive approach can provide more useful implications in terms of applying its potential value within the development of future research. For ease of explanation these are listed again as follows:

- H1. Consideration of economic trends in a manufacturing SME correlates with the priority of the R&D sector within the organisation.
- H2. Keeping reliable financial conditions in manufacturing SMEs correlates with the success of new product development.
- H3. A strategy of manufacturing SMEs that matches community expectations affects the priority of the R&D sector in an organisation.
- H4. Management goals set by a manufacturing SME correlate with the success of new product development.
- H5. Keeping an adequate labour force in a manufacturing SME affects the

success of new product development.

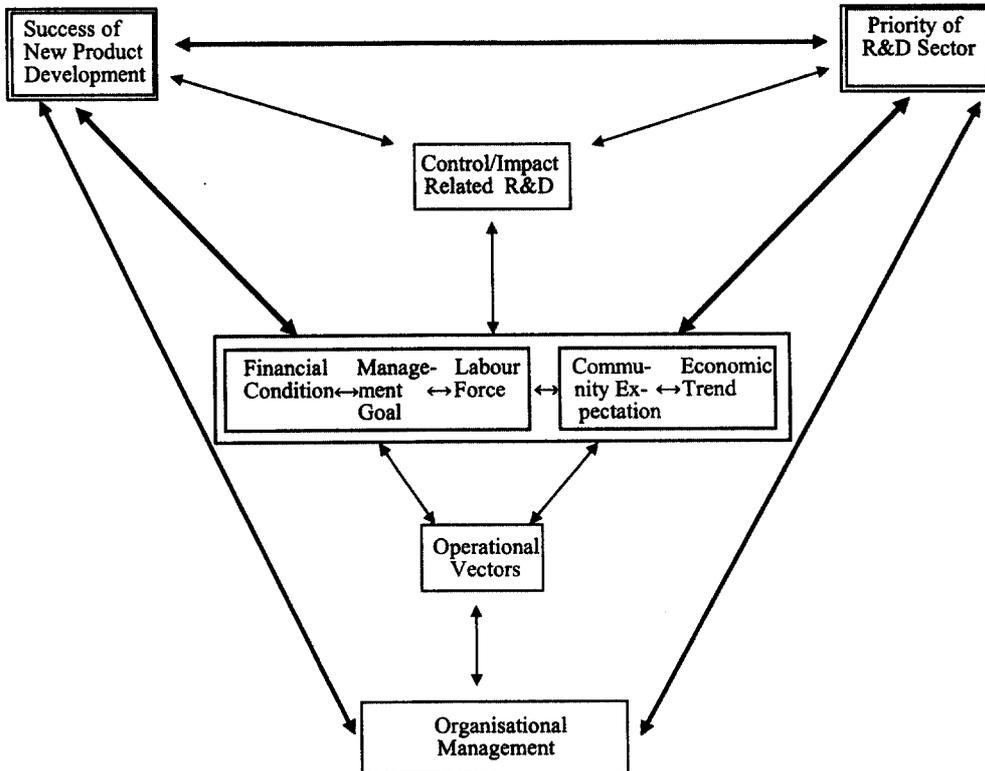
The complex relationships between the two main variables used in this study have already been described in Table 1 & Figures 1. The origin of an aggregated model comes from considering simultaneously both the results of the inter-factor correlations and the theoretical contexts of each variable as reviewed in above sessions.

The final model is shown in Figure 2. In a word, the figure illustrates the complexity of the interrelationships between various fac-

tors among the related variables. The two large boxes represent the main R&D related factors, while smaller ones in the centre or in the top half of the diagram include the process of implementing strategic factors or the related indirect variables. A multi-level approach of measurement which aggregates the verified framework into a unified system is introduced.

In this model, the significant extent of each statistical correlation or intuitive relatedness is indicated by the various lines seen from or to each variable box. The

Figure 2 A Model of the Organisational Management and R&D Activities of Manufacturing SMEs



thicker sets of arrows signify the stronger correlations between factors demonstrated in the previous stages.

Consequently seeing this model in total enables us to formulate a conclusion, as follows: 'Any manufacturing SME which seeks to promote its R&D performance as revealed in the success of new product or new technological development, needs to put its managerial strategies into a direction shown by the left half of the model, whereas any firm seeking to put a higher priority on R&D activities than the others should direct its managerial strategies in the direction of the right half of the diagram.' In reviewing Figure 2 and each conclusion from the five propositions, a conclusive theorem can be confirmed:

*'If manufacturing SMEs wish to give a higher priority to R&D activities compared to others such as marketing, production etc., their managerial strategies must not only be focused on their governmental policies, economic indices, or changes of various cost etc. but also consider their social responsibility to the community in which they are situated, take account of relevant socio-economic or political pressures on the R&D sector, and be cognisant of environmental or socio-ethical issues. However, on the other hand, if a manufacturing SME desires that their new product development programs or new*

*technological developments are to be more successful they have to focus their managerial strategies on the establishment of secure financial resources, good current profitability, achievable or potential objectives, and flexible manpower structures in relation to outside labour markets.'*

In other words, the theorem is shown that to achieve a higher rate of success in launching new product developments an SME needs to concentrate its organisational management on internal areas such as financial conditions, management goals, and an adequate labour force, but to establish a higher priority within the firm first for promoting R&D activities it is required to concern itself much more with outside policies, economic indices or community expectation of the R&D activities etc. From such a prospective, a conclusion is able to be derived which states that placing a higher priority on the R&D sector does not of itself guarantee success for new products or new technological development. Focusing on the quantitative size of R&D in developing countries provides occasionally an example of this perspective.

## VI. DISCUSSION AND CONCLUSIONS

The manufacturing SMEs are faced with

a situation where the new opportunities offered by the fall in production thresholds due to economies of scale are offset by the desperate requirements of new technologies with respect to the level and complexity of intangible investments and the marketing of products on a customised basis (OECD, 1992; Silverberg and Soete, 1988). This is especially true of intangible investment, which combines the ability to obtain information through more or less obvious views of new technology, markets and competition; the ability to carry out R&D; the standard of a firm's organisation; and the training of human resources (Bannock, 1980).

If an outstanding element which affects business performance can be identified, then the owner or top manager could systematically focus upon it. This study was undertaken from such a viewpoint in order to determine implications which could come out from an analysis of major issues relevant to strategic elements and R&D performance within the same manufacturing area. No doubt this study of small and medium sized organisations had a good deal to do with the exploratory power of the findings. As empirical sections showed, most of the key findings are meaningful and relevant to manufacturing SMEs facing strategic, directive, and structural environments in relation to their R&D ac-

tivities.

As a core element of this study, organisational management was demonstrated as having a very significant relationship with the selected R&D activities. The detail of the results showed that economic trends and community expectations correlate significantly with the higher priority given to the R&D sector whereas financial conditions, management goals, and adequate labour force correlate with the success of new product development. They are enough to show some practical and simply stated implications for SMEs. Table 1, for example, shows very valuable correlation between adequate labour force and success of new product development. This implies a degree of 'bestness' of organisational management. This indicates that manufacturing SMEs that currently has a labour force which is adequate both in size and competence are likely to be more successful in implementing the related R&D activities in manufacturing SMEs. Considering the contents discussed in these key findings, a conclusion can be made as follows: manufacturing SMEs which wish to be more successful in their R&D activities or give a higher priority to their related R&D sector, their level of organisational management must be characterised by high involvement, high concerns, a continuous strategic mind, and positive investment in implementing related

managerial strategic activities.

Some of these results may supply practical implications to management because the factors related to SMEs and their specific applications are clearly shown. However, based on this study, several directions for future research can be required. Additional study should be conducted with different firm samples to determine the stability and generalisability of this study methodology. If possible, the future research should include exploring the impact of various demographic variables on practical measurement. Finally, a longitudinal research should be able to address the question of whether the related variables change as the SMEs' business grows and profits stabilise.

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