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The adoption and modelling of the strategic productivity management approach in manufacturing systems

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Introduction

From time to time, the industrial world has witnessed the emergence of technologies and managerial philosophies due to increased competition. Particularly, this trend has been phenomenal over the last 20 years. A literature overview of manufacturing status covering this period indicates that there has been an upsurge in the emanation of various concepts and philosophies since the 1980s. Out of them all, the most noticeable philosophy that still dominates the manufacturing systems is total quality management (TQM). Though plenty of models, methods and techniques have been brought out to effect TQM, the manufacturers seem to have gained very little benefit. A critical analysis of interview and questionnaire responses from executives and various managerial cadres in the manufacturing arena indicated that the quality programmes initiated as part of TQM programmes were found to affect productivity to a great extent. Also, the retardation in productivity improvement was found to be a major cause in declining interest among the manufacturing community in carrying out quality improvement programmes. However, very little work in integrating productivity with quality improvement frameworks has been carried out during the recent years. This realization made it imperative to carry out research on productivity

The authors are grateful to the manufacturers and experts who responded to the questionnaires; the director of the manufacturing firm for allowing his premises to be used for testing the application feasibility of the SPM model; Dr A. Gunasekaran, University of Vaasa, Finland for sending his full paper[1] which gave us greater insights into the strategic approach to productivity management and the anonymous reviewers whose comments enabled us to improve the paper considerably.

management, with the major objective of designing a model that could be integrated with a quality management model that has received acceptance from the manufacturing community. This article illustrates the first phase of research work, which consisted of an exploratory work on the adoption of concepts of strategic management and strategic quality management (SQM), to design a model called "strategic productivity management" (SPM). After reviewing briefly the status of productivity management in literature and manufacturing companies, this article proceeds to the design of the SPM model. A case study is briefly reported, to describe the efforts that are being made to implement the proposed model. Though the implementation progress is at a very primitive stage, it helps to reveal the features of implementation feasibilities. In its conclusion the article appraises the tangible and intangible benefits of implementing the proposed SPM model and explores the future direction of research work.

Productivity studies in the literature

Though productivity would have been man's concern as soon as he became a manufacturer, its very formal presentation was noticed in the literature only in the year 1766[2]. Thereafter a lot of work emerged in this area with various definitions and concepts. During the early 1900s various models to improve productivity in complex industrial enterprises were brought out. A comprehensive literature survey on productivity studies in manufacturing systems over the last 20 years revealed two main aspects:

(1) the work on productivity in the initial days was biased towards only its improvement and, later, slowly it shifted to its management;

(2) its reception among the manufacturing community was moderate during the early days (1970s).

However, when the TQM movement gained momentum from the early 1980s, productivity concepts were pushed to the background. This resulted in the declining trend of productivity literature over the years. As indicated in Table I, from the 1980s the frequency of articles appearing in journals was reduced by a very insignificant extent.

Meanwhile, during the mid-1980s, attempts were made to implement TQM concepts either as a whole or in part (like initiating quality circle programmes). However, during the late 1980s and early 1990s sceptical observations emerged over the real benefits of TQM. Particularly, a variety of articles such as Juran[3], Dale and Lightburn[4] and Noci[5] dealing with the failures of quality improvement projects appeared. More recently, Garvin[6] has claimed that the failure of TQM projects are reported to an extent of 70 per cent. At the outset, a literature review has indicated a disproportionate growth of quality and productivity studies, which has resulted in insignificant improvement in overall manufacturing systems management.

Years	Total number of articles surveyed	Articles on productivity	Percentage of articles on productivity
1975	158	105	66.5
1976	167	107	64.1
1977	171	112	65.5
1978	172	111	64.53
1979	176	116	65.9
1980	174	109	62.64
1981	173	97	56.1
1982	178	85	47.75
1983	182	78	42.86
1984	179	59	32.96
1985	176	46	26.14
1986	177	34	19.2
1987	177	33	18.64
1988	192	19	9.89
1989	202	17	8.41
1990	228	17	7.46
1991	240	22	9.17
1992	270	30	11.11
1993	342	37	10.82
1994	358	60	16.76
1995	302	60	19.87

Table I. Literature survey on productivity (manufacturing/ production areas)

Survey among the manufacturing community

In order to study the trend in applications of productivity in manufacturing systems, a survey was conducted among the manufacturing community. The survey was carried out by interviewing and collecting questionnaire responses. First, a questionnaire containing ten questions was developed. The authors' earlier research experiences revealed that manufacturers feel freer to express their genuine opinions if their identities are not revealed. Further, manufacturers find it very difficult to understand the terminologies used by academicians. Hence, every care was taken to design the questionnaire in such a way that the identities of the manufacturers need not be revealed. To make the questionnaire simpler and free from technical jargon, its draft was introduced to a few manufacturers and postgraduate engineering students to find out if there was any difficulty in understanding the terms. After thorough revision, the questionnaires were sent to 243 manufacturers. The questionnaire is shown in the Appendix.

A total of 158 questionnaires were returned with full response. Also, 17 manufacturers from various parts of the world were interviewed when they came to India on different assignments. This shows a response rate of 72 per cent, which was considered to be very good. Also, many addresses were taken from various magazines and journals, in which postal codes were unavailable. Therefore there was every chance that the envelopes bearing questionnaires to those addresses would not have reached the targeted destinations.

Of the total respondents, 7 per cent were from the Far East; 30 per cent were from Europe; 35 per cent from the USA and Canada; 20 per cent from Asia Pacific and 8 per cent from African countries. The respondents indicated the size of their manufacturing firms from their respective countries' standard. Accordingly, it was found that of the total respondents, 11 per cent were from small size manufacturing firms; 57 per cent were from medium size manufacturing firms and 32 per cent from large size manufacturing firms.

It was also found that 4 per cent of the responses were from chemical manufacturing firms; 22 per cent of the responses were from electronic gadgets manufacturing firms; 27 per cent of the responses were from automobile manufacturing firms and 47 per cent of the responses were from manufacturing firms of general types (those manufacturing components like pumps, machines, nuts, bolts, etc.). Considering this, the response rate was declared very significant and widespread. The opinions derived from the questionnaires have been analysed and their concise form is presented in Table II.

Framework for manufacturing systems management

Besides aiding in drawing inferences about productivity and quality, the analysis of both the literature and company surveys indicates the importance of cost effectiveness and time management in manufacturing systems. Many manufacturers specially wrote that any model that does not integrate cost-effectiveness and time management is found to receive very little appreciation in a manufacturing environment. Based on these interview responses of manufacturers and with references to well-established literature and grounded theory, a conceptual model for manufacturing systems management was explored and is shown in Figure 1.

As shown, effective manufacturing systems management requires the integration of productivity, quality, cost and time. A number of available quality management models integrate time and cost management[7]. While some academicians like Maani[8] (in 1987) and Gunasekaran[1] (in 1994) pointed out the need to integrate productivity and quality issues, it appears that no quality management model exists which integrates productivity directly. Hence, the present situation calls for the development of a model for productivity improvement which should integrate with the existing successful quality management model, so as to be acceptable to a manufacturing community.

Scope of the work

Based on the preliminary work that was explained in the previous sections, the scope of the research work was defined as follows:

Corresponding question number	Description	Majority response (more than 60 per cent)
1	Status of productivity improvement programmes in comparison to TQM programmes	0-30
2	Trend in implementing productivity programmes during the last decade	Decreased
3	Orientation of productivity improvement efforts	No clear approach
4	Budget allocation for productivity programmes	0-30
5	Models used while carrying out productivity programmes	No particular model
6	Cost-effectiveness of productivity programmes	Never found to offer favourable returns
7	Time management after implementing productivity programmes	Worsened
8	Impact of advanced technologies on total productivity improvement	Total productivity not improved
9	Impact of TQM programmes on productivity	Productivity decreased
10	Type of model preferred to adopt for productivity enhancement	Any model integratable to presently used quality management system model

Consolidated comment: A model to enhance productivity by integrating quality, cost and time management will be useful to manufacturing community

Table II. Analysis of questionnaire responses

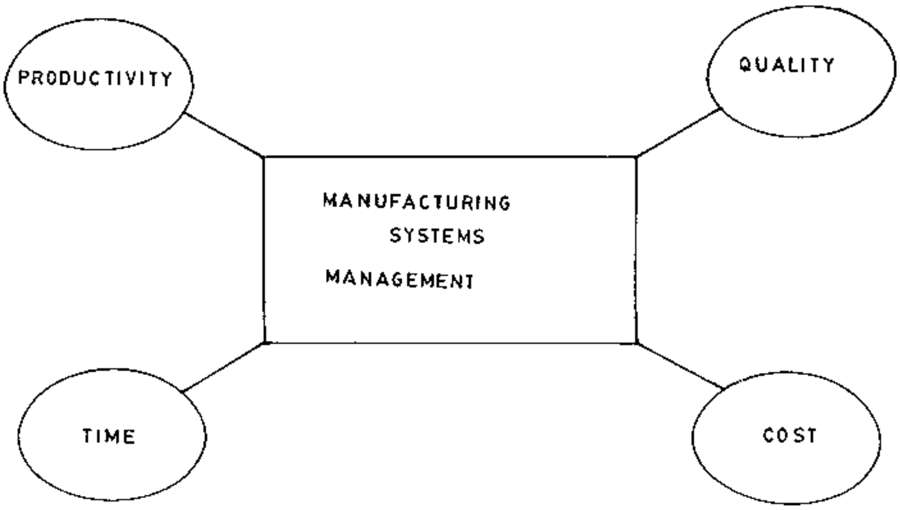

Figure 1. A conceptual model for manufacturing systems management

(1) Conceptualization of model for productivity management.
(2) Identification of enablers and determination of strategic elements of productivity management.
(3) Development of a model incorporating the strategic elements of productivity management.
(4) Studying the implementation features of the developed model by conducting a pilot study.
(5) Devising a generalized plan for implementing the developed model.
(6) Implementation of the model.
(7) Development of a system framework for the strategical elements of the model.

It was also proposed to check the compatibility of the proposed SPM model with the existing model on strategic quality management[7]. The research covering numbers (1-5) in the above defined list is described in this article.

SPM: its need, conceptualization and definition

It was considered at this stage that the developments which have taken place in the field of strategic management have been found to contribute towards new innovations in managerial approach. This trend emphasized that the strategic approach on productivity management was imperative and could be made feasible if reference was made to the work already done in this direction for quality management. This work[9] recognized nine quality strategies and established a focused system model under the terminology "strategic quality management" (SQM). While it has attracted literature importance[10], a pilot study involving its implementation revealed that, though its impact on continuous quality improvement is significant, its resultant quantitative outcome in the process of manufacturing systems management is quite negligible. Initial study into experiences of its implementation revealed that, if this model also supports productivity improvement, it would have significant impact on manufacturing systems management. At this juncture it should be noted that, today's manufacturing systems have encompassed quality system models as stipulated by TQM concepts and ISO 9000 series standards. Hence, any model on productivity management would be able to integrate itself with the manufacturing environment only when it is in line with the quality management system model that is being adopted currently. This is because no manufacturer would be agreeable to dismantling an existing quality system, which would have been developed at the expense of considerable money and time. Under these circumstances, it was understood that it would be feasible to carry out further work in parallel with the research study that was being undertaken on strategic quality management. Also, reference was made to the concepts of strategic management[11,12] which have been found to contribute significantly towards manufacturing management. Based on the principles and concepts inferred from these works, the process of SPM is conceptualized and defined as "the process by which productivity management activities focus towards the long-range direction and progress of productivity enhancement strategies by ensuring the careful formulation through strategic productivity planning, proper implementation through vital productivity strategies, and continuous evaluation through productivity improvement and control". Also in line with SPM process, the conventional definition of productivity is reoriented under the term "strategical productivity". Strategical productivity is defined as the average of the ratio between actual output and strategical (targeted) output pertaining to all productivity strategies. According to this definition, strategical productivity is computed for each productivity strategy and the average is considered for further evaluation. The conceptual elements, enablers and strategical elements of SPM inferred are described in the following sections of the article.

Determination of management perspectives

Abundant supportive evidence is available in the literature[13] to emphasize the need for management commitment to ensure the success of managerial programmes. SPM will not be an exception to this. Hence, definite conceptual elements should be recognized for establishing management's perspective on managerial programmes. "Understanding managerial vision" and "development of policy" have been found to be the two conceptual elements which determine the management's perspectives over longer and shorter durations. The top management personnel should be interviewed to bring out the company's vision about its productivity management. Also, the company's policy on achieving its mission should be identified by interviewing middle-level managerial personnel. The main difference between vision and policy statements is that the vision statement will not vary until the amalgamation or transfer of management of the firm, whereas the policy statement is bound to vary due to the dynamic behaviour of a manufacturing environment. The statements describing vision and policy should be simple, understandable to all and implementable in practice.

Declaration of long-term and annual productivity objectives

The vision statement on productivity should declare and list the long-term objectives of the firm, whereas the productivity policy statement must be utilized to list annual objectives. In short, long-term and short-term objectives are enablers of SPM process and are the expanded versions of vision and policy statements respectively.

Development of SPM system

While the previous phase, which constituted the development of vision and policy statements, formed the head and brain of SPM, the system responsible for implementing SPM and bringing it up in practice, constitutes the heart of the SPM programme. The field of productivity engineering reveals plenty of both mathematical and management models. Readers interested in reviewing these models should refer to[2,14]. Though the developers of these models could show some empirical evidence of the models' effectiveness, most of them in practice could not find their application in manufacturing environments. Analysing the previous attempts on improving productivity in some manufacturing firms revealed that the lack of manufacturing focus in previous models was found to be the main cause of their failure to incorporate themselves with manufacturing systems. Hence, it was found necessary to develop a conceptual model for the SPM system with the incorporation of "manufacturing focus" concepts[15]. Accordingly, a framework for the SPM system encompassing planning, implementation, controlling and evaluation as the cornerstones and continuous productivity improvement as the ultimate output was explored. This is shown in Figure 2.

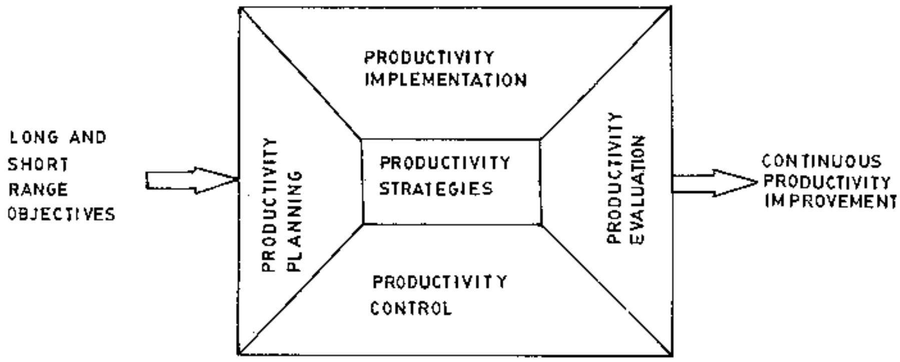

Figure 2.
Framework of SPM system

Productivity strategies

The research experience[9] on SQM revealed that the determination of governing strategies forms the first step, while developing a manufacturing-focused model of strategic management systems. Hence, to develop the proposed SPM system model it was decided to determine the productivity strategies which will be forming the pillars of SPM. Several months were spent in identifying productivity strategies by referring to a large number of productivity models contributed by both academicians and manufacturers. When this attempt failed to provide an exhaustive list of productivity strategies, the contributions to research work on SQM[9] were considered. Consequent to this, the old-style single manufacturer productivity system was considered and analysed. It resulted in the identification of nine productivity strategies. These strategies are briefly discussed in the following subsections.

Tapping human knowledge

Since an old-style single manufacturer was the only person to monitor all manufacturing functions, he was able to tap his knowledge continuously for better productivity. This helped him to carry out better strategic productivity management. Hence models and methods for tapping human knowledge in today's complex manufacturing systems form an important productivity strategy.

Productivity information management

An insight into the activities of an old-style single manufacturer would reveal ideal information management being carried out intuitively by him, which must have played a vital role in strategic productivity management. Hence formulation of productivity information management in a complex manufacturing system forms another vital productivity strategy.

Target attainment

An old-style single manufacturer was able to fix definite targets for attaining productivity and made continued efforts to attain them. Though difficult, this strategy of fixing targets and endeavouring to attain them forms a very important productivity strategy in complex manufacturing systems.

Failures checking

The old-style single manufacturer was able to trace the failures causing productivity retardation and could avoid occurrence of further failures. Hence methods and techniques aiding in checking failures of productivity constitute another important strategy in any SPM programme.

Feedback incorporation

Since the old-style single manufacturer was solely managing his simple manufacturing system, he was able to gather feedbacks on productivity efforts and could take corrective actions. Hence a concrete technique to nurture the feedback of SPM programmes forms a vital productivity strategy.

Management of productivity system elements

Though the old-style single manufacturer would not have adopted any documented procedure to manage the productivity system, he was able to do so in his mind because of the simplicity of the process. However, today the manufacturing systems are so complex that they have to be managed with the help of elements such as procedures, records, work instructions, etc. Hence managing these elements forms a vital productivity strategy.

Productivity training management

The old-style single manufacturer trained continuously to meet ever-changing customer demands. Today in manufacturing firms, formal training programmes are conducted to impart skills and knowledge for improving productivity of various functions. However, due to poor management, they are seldom found to evoke better productivity. Hence managing training programmes towards increasing productivity forms an important vital productivity strategy.

Practical productivity auditing

In the old-style single manufacturer's manufacturing system, it was feasible to conduct an informal productivity audit. That is, the productivity audit results could be implemented, which made the whole programme very effective. In today's complex manufacturing system, conducting a productivity audit with the feasibility of practical implementation in mind constitutes an important productivity strategy.

Productivity counselling

The productivity models currently available are found to be devoid of a very important human psychological need, namely counselling. Even a very casual overview on manufacturing status would reveal that psychological setbacks such as frustrations, disappointments, etc. arising out of manufacturing and/or family environments are found to affect productivity. In the case of the old-style single manufacturer, his manufacturing system was an integral part of his family environment, conducive to receiving better counselling to improve productivity. Since in complex manufacturing systems the family and manufacturing environments totally or partially differ, psychological setbacks are found to be alarming. Counselling is the solution – to avoid, or reduce, psychological setbacks affecting productivity. Hence counselling techniques for productivity improvement forms a vital productivity strategy.

Productivity planning

Design of all functions such as procurement, product design, marketing, etc. with reference to all the productivity strategies identified above marks effective productivity planning. As mentioned earlier, productivity planning is a cornerstone of SPM and it should be a continuous process.

Productivity implementation

The productivity planning must correspond with the implementation. The end of initial productivity planning must be marked by the development of a productivity manual, to be referred to during implementation.

Productivity control

The performance of a productivity programme must be controlled by proper follow up and expediting procedures. The productivity manual must also stipulate the proper documents for this purpose.

Productivity evaluation

Each and every cycle of a productivity programme must be marked by its overall evaluation. This must be compared with the set productivity targets. The output of productivity evaluation must be fed into productivity planning for further refinement, modification or improvement as the case may be.

Performance evaluation in market conditions

The SPM process will gradually weaken if its performance is not evaluated frequently under market conditions. The market conditions must cover both internal and external environments. The internal environment may be subjected to performance evaluation among the teams or functions. External environment refers to immediate market competitive forces. If the SPM process reveals untoward happenings, such as poor performance in the market, a drop in productivity, etc., which indicate the need for total refinement, the productivity policy must be modified or changed to meet the requirement. There will always be noticeable features which could be referred to for further improvement of the SPM process. These features must be diverted towards the phase which involves the modification of long-term and short-term productivity objectives.

SPM modelling

The significant phase of this research work was modelling SPM by adopting the developments in strategic management, and integrating conceptual elements, enablers and strategical elements identified during the research work. The SPM model developed during this research work is shown in Figure 3.

As shown, four phases are identified. The first phase begins with establishing the productivity mission and ends with declaring the productivity policy. This phase determines the aspirations of management with regard to productivity improvement. During the second phase, the objectives are declared considering all interactive elements. The third phase forms the heart of the model during which the SPM system is developed using appropriate tools, techniques and methodologies. The fourth phase is devoted to assessing the results of productivity improvement effects which will have to be compared with market conditions.

Case study

Over 50 company executives were interviewed to obtain their opinions about the proposed SPM model. Minor queries raised by them were clarified. However there was no suggestion of any modification. This ensured the acceptability of the model to the manufacturing community. Further, to validate the model to the real time situation it was decided to carry out a pilot implementation attempt. Hence a fabrication company executive (whose opinion of the model had been sought earlier) was approached. Since he could not segregate any small unit for conducting an implementation study, he referred us to a subcontracted unit of

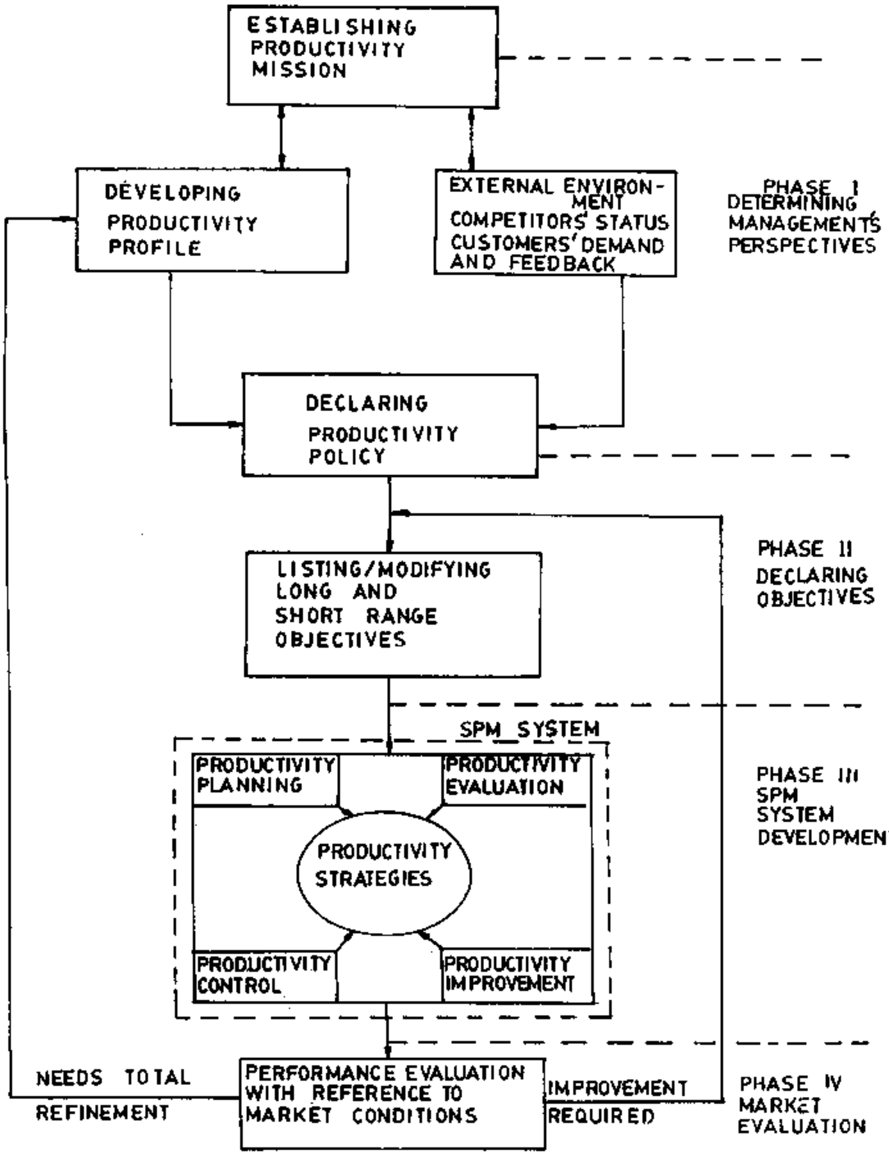

Figure 3.
SPM model

the company. The director of this company, after hearing the briefing of the model, agreed to allow his premises to be used for the implementation study. This subcontracted company employed over 50 employees belonging to different levels with proper skills. The last year's turnover was around Rupees 50 lakhs and manufactured 65 per cent of the parent company's products. The implementation was carried out in seven months. The time schedule adopted during implementation is shown in Figure 4.

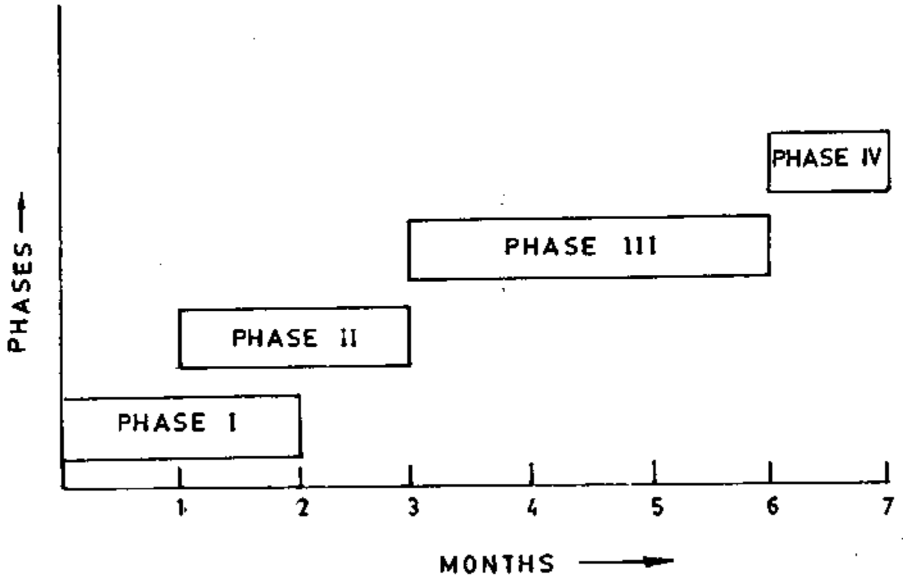

Figure 4. Schedule of implementation

A detailed explanation of the implementation experience is not within the scope of this article. However, a brief review of the implementation experience is presented in the following sections.

Determination of management's perspectives

During the first phase of the pilot implementation study, the management's perspectives towards productivity were assessed and brought out in the form of a "productivity mission statement". First, the past history concerning management's way of dealing with productivity improvement was analysed. Then the director of the company was interviewed and, based on the outcome ,the productivity mission statement was declared. Based on the productivity mission statement, the productivity policy statement was prepared after consultation with middle-level managerial personnel. Though there was some difficulty in developing a productivity profile (which was rectified later), the activities of this phase proceeded smoothly.

Declaration of objectives

To identify the imperative long- and short-term objectives of the firm with reference to productivity enhancement, four sources of information, namely the productivity mission, productivity policy, productivity vision and external environment, were used. Further, some of the objectives which were informally available and followed, were collected. Co-operation was received from both management and employees, since it led to a clear understanding of the productivity objectives of the firm.

SPM system development

The activities of this phase started with productivity planning. For all the productivity strategies, implementation plans with time schedules were drawn. Also, the productivity tools and techniques were selected from the literature[2] for implementation of each strategy. As shown in Figure 4, this phase took four months for completion and was beset with implementation difficulties. First, it was difficult to convince both management and employees about the credibility of techniques selected for implementing each strategy. Even after this, the employees found it extremely difficult to use the productivity techniques along with the efforts to implement quality techniques. Though the activities of this phase were completed, with great difficulties, they highlighted areas needing future research.

Market evaluation

The outputs of phase three were subjected to evaluation, with reference to market conditions such as competitors' status, comparative performance of employees, scope of competition with reference to national and international markets, etc. The evaluation covered both intangible and tangible forms. The major intangible benefits identified are increased interest and awareness in improving productivity, provision for effective employee involvement in productivity management, development of a productivity system that ensures systematic efforts for productivity management, and methodologies for developing a productivity audit report that is acceptable in practice for further considerations. Tangible benefits were noticed also in the form of increase in productivity by 19 per cent, and reduction of lead time by 26 per cent. In order to have precise evaluation, we decided to study the possibility of adopting benchmarking principles.

On the whole, the pilot study indicated the worth of the SPM model. However, it revealed that further research is required in the direction of SPM system development.

Summary and conclusion

This research work brought out initially the importance of the initiation of a productivity management programme based on the strategic management concepts. A theoretical formulation was made to identify, define and model the restructured concepts under the term strategic productivity management. This was followed by modelling and implementation. The implementation experience was very smooth during the first and second phases. Even when difficulties arose during these phases, they were tackled by applying strategic management approaches. However during the third phase, which constituted the use of productivity tools and techniques, the pace of implementation was retarded. This was due to trying to develop a SPM system with the available conventional productivity tools and techniques. These tools and techniques were not compatible with the quality system which was developed based on the

SQM approach[9]. Hence tools and techniques adaptive to the quality system needed developing for manufacturing acceptance. Though it was found difficult, this phase assumed significance because of its integration with the SQM model, which is an imperative for optimal manufacturing systems management. The output of this phase was subjected to performance evaluation with market conditions. This was considered to be phase four, and the results showed the following major intangible benefits:

- increased awareness of the importance of productivity;
- increased employee involvement in productivity management;
- system development for productivity management;
- a practically feasible productivity audit report.

The main tangible benefit is that the implementation of this SPM model is found to be responsible for increasing productivity by 19 per cent. Besides, the customer lead time is reduced by 26 per cent. Though the management feels happy about these benefits, from a research point of view this was felt to be insignificant. Detailed analysis of the implementation experiences indicated that the development of a manufacturing focused model for a SPM system with SQM compatible tools and techniques would significantly increase the benefits. Altogether, it is felt that the proposed model has opened an avenue for applying strategic management concepts in productivity management and indicates the need for more research work into developing the manufacturing focused SPM system model. The authors are currently working in the direction of developing such a manufacturing focused SPM system model based on the theories contributed by Bozarth[15].

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Appendix: survey questionnaire on productivity

(1) What is your rating of the status of productivity improvement programmes in comparison to other programmes like TQM, business process re-engineering, etc?
- 0-30% ☐
- 30-70% ☐
- 70-100% ☐

(2) What is the trend of implementing productivity improvement programmes during the last decade in your organization?
- Increased trend ☐
- Decreased trend ☐
- Moderate trend ☐

(3) What is the orientation of productivity improvement efforts in your organization?
- No clear approach ☐
- Productivity evaluation and improvement approach ☐
- Productivity management approach ☐

(4) What is the budget allocation for productivity programmes?
- 0-30% ☐
- 30-70% ☐
- 70-100% ☐

(5) Which models are used in carrying out productivity programmes?
- No particular model ☐
- Some statistical and mathematical models ☐
- Productivity management models ☐

(6) What is your experience on the cost-effectiveness of productivity programmes?
- Favourable returns ☐
- Never found to offer favourable returns ☐
- Neither favourable nor unfavourable ☐

(7) What is your experience on time management after implementing productivity programmes?

- Improved after implementing productivity programmes ☐
- Worsened after implementing productivity programmes ☐
- No effect ☐

(8) What is your experience on the impact of advanced technologies like CIM, FMS, IT, etc. on the improvement of total productivity?

- Energy productivity improved, but total productivity decreased ☐
- Capital productivity slightly improved but total productivity decreased ☐
- Total productivity improved ☐

(9) What is your experience on improving productivity after implementing TQM programmes?

- Productivity increased ☐
- Productivity decreased ☐
- No effect ☐

(10) What type of model would you prefer to adopt to enhance productivity from the present level?

- A model integratable to presently used quality management system model ☐
- Already available productivity management model ☐
- Already available mathematical and statistical models ☐

Please write your comments on productivity enhancement efforts in modern manufacturing systems.

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