ELSEVIER

Int. J. Production Economics 36 (1994) 169–183

international journal of
production
economics

Improving productivity and quality in manufacturing organizations

A. Gunasekaran[a,*], A.R. Korukonda[b], I. Virtanen[a], P. Yli-Olli[a]

[a] *School of Business Studies, University of Vaasa, P.O. Box 297, 65101 Vaasa, Finland*
[b] *Department of Management Sciences, School of Business, St. Bonaventure University, St. Bonaventure, NY 14778, USA*

Received 15 January 1993; accepted in revised form 1 February 1994

Abstract

Today most firms are interested in a strategic approach for improving productivity and quality in their organizations. Consistent with this thrust, this paper attempts to provide a strategic framework for such efforts. The main focus of this paper is on integrating various functional groups of a manufacturing organization and highlighting the role of new manufacturing concepts and technologies in such integrations. Comparison of earlier and present practices of production operations signifies the importance of JIT, TQM, and FMS in improving the integration of various functional areas and alignment between business, manufacturing and quality improvement strategies. The role of knowledge workers and support services play a dominant role in improving productivity and quality in manufacturing organizations, especially in advanced manufacturing systems such as JIT, FMS and CIM.

Key words: Improvement; Productivity and quality; Functional integration

1. Introduction

Productivity is an aggregated concept of overall efficiency/effectiveness of the organization concerned. At the firm level, productivity should be understood as a dual concept, i.e. productivity as the principle, as briefly described above, and productivity as a ratio. Thus efficiency and effectiveness are two major subconcepts of productivity [1]. The benefits of productivity and quality improvements lie in strategic advantages such as increased market share, but also bring internal gains such as higher wages and bonus. The purpose of this paper is to discuss the following issues: (i) recent developments towards improving productivity and quality, (ii) importance of integrating functional areas in improving productivity and quality, (iii) role of new manufacturing concepts and technologies in improving productivity and quality, and (v) a strategy development for integrating the functional activities with an objective to improve productivity and quality in manufacturing organizations. An attempt has been made to discuss these issues in a systematic manner with an aim of providing some insights into the recent developments of productivity and quality improvements in manufacturing organizations.

Even though historically quality and productivity have been dealt with separately, while establishing strategic improvements, they should be considered together in strategic and operational

* Corresponding author.

SSDI 0925-5273(93)00023-4

planning. This is because of the fact that quality has not been given equal importance as compared to productivity. Mostly, companies have concentrated upon increasing the output rate and considered quality as synonymous with cost. In addition, they treated as being more expensive. But the recent developments and the focus are different. An increase in quality does not only reduce cost, but also improves productivity by eliminating any rework and unnecessary inspections, that is, by the use of productive resources. Productivity as a measuring tool presents many opportunities for evaluating the performance of different divisions in a company and to caution the managers against inefficient operations and wastage of resources. Quality has also moved beyond inspection and has been gaining importance as a strategic tool for increasing the efficiency of the company by way of improving resource utilization and satisfying the needs of customers in terms of price and reliability. Nowadays, most of the activities are decentralized in a company. Each department works on the basis of improving the efficiency of its own system. However, their individual objectives should support the goal of the organization as a whole as the operations of a department are constrained by one another. That is why there is a need to integrate various functional areas in the manufacturing system for improving productivity and quality. Furthermore, there should be a smooth flow of information concerning the company's policies and goals. Considering the role of integration in improving quality and productivity, an attempt has been made in this paper to develop a strategic framework for improving the integration between various functional activities in manufacturing firms in the light of modern technologies and conceptual insights.

Productivity is the ratio of output to input. In otherwords, it shows the degree of efficiency in doing work in an industrial activity. In a manufacturing company, productivity can be defined in terms of how the resources such as materials, labor, and machines have been utilized to produce quality goods and services. Traditionally input has been controlled with a view to minimize the wastage of resources and to improve productivity in such manufacturing companies. However, there is a shift in factors controlling the input resource utilization. For example, direct labor which has been playing a significant role in improving productivity earlier has been significantly reduced by automation. Knowledge workers and other support activities such as computer operators, maintenance workers and draftsmen play a significant role in integrating various functional departments such as marketing, distribution, finance, design and engineering in a manufacturing company by improving the communication between them. Even among the machine tools, new trends toward flexibility, changes productivity issues in the company to a large extent, so much so that it cannot just be measured by the number of machine tool hours run alone. Rather, how flexible the machine is in terms of routing the products, performing different operations, and the maintenance required. Advanced technologies also bring in their share of complexity into the productivity issue. For instance, the benefit of using a particular raw material cannot simply be measured by calculating the cost alone; one should also account for future cost which is related to a particular raw material concerning the quality of products and processing capabilities. New manufacturing concepts such as just-in-time (JIT), zero inventories (ZI), and total quality management (TQM), and technologies like flexible manufacturing systems (FMS), computer-integrated manufacturing systems (CIM), and optimized production technology (OPT) have a tremendous impact on the output of manufacturing companies. Hence, there is a need to focus our attention on how these new ideas and technologies of production can be useful for practitioners in formulating productivity and quality improvements strategies.

There are numerous research reports [1–24] available on productivity and quality improvements. Most of them deal with benefits that could be achieved by localized improvements such as set-up reduction, smaller batch sizes, use of computers in information systems. However, they do not offer any concrete strategic approach on how to improve productivity and quality of the whole organization against the background of business strategy. Realizing the importance of such an approach, a framework has been offered in this paper to improve productivity and quality in manufacturing organizations. The main focus of this paper is to

develop suitable strategies for the purpose of integrating the activities of various functional departments in manufacturing organizations, using recent developments in production concepts and technologies.

This paper is organized in the following manner: Section 2 presents the recent developments towards improving productivity and quality. Section 3 describes how the integration of various functional activities helps to improve productivity and quality. The role of new manufacturing concepts and technologies in improving productivity and quality is presented in Section 4. Section 5 presents a strategy development for improving productivity and quality. The strategic options are presented based on the characteristics of the company. Section 7 concludes the paper.

2. Recent developments towards productivity and quality in manufacturing systems

There is a number of research reports in the literature to deal with productivity and quality improvements. Drucker [2] points out the importance of knowledge workers and support services in improving productivity and quality in manufacturing organizations. Gitlow and Hetz [3] studied the impact of product defects and its impact on productivity. They also observed that reducing the defect level increases productivity and provides opportunities to utilize the available resources effectively. Recent changes in production methods such as JIT, ZI and TQM and technologies such as FMS, OPT and CIM have focussed on improving productivity and quality of manufacturing organizations. Judson [4, 5] offered a framework for integrating business and productivity improvement strategies. He also offered some guidelines on how to align business and productivity improvement strategies. Prokopenko [6] presented a detailed analysis of productivity management including productivity measurements. Shapiro [7] explained the importance of integrating marketing and manufacturing strategy in increasing the organizational effectiveness. In addition, there are many reports (for example [8, 9] that deal with productivity and quality as strategy variables. Rossler and sink [10] discussed issues of productivity and quality problems considering the recent trends in manufacturing and service environments such as, automation, flexibility, computers and multifunctional workers. In particular, they emphasized the characteristics of good measurement systems such as, simple and effective, flexible, adaptable, and dynamic and their role in improving productivity and quality.

Gold [11] offered some guidelines for integrating productivity improvements within the strategic planning. Productivity improvements provide a means not only for gaining competitive advantages, but also for minimizing the threats posed by increases in factory prices and decreases in competitive prices. However, very few attempts have been made to formulate a strategy from the total system point of view which includes integrating various functional areas, business, and productivity and quality improvement strategies. Several authors [7, 12] have attempted to define the dimensions or components of manufacturing strategy as a statement of how manufacturing supports the overall business objectives through appropriate design and utilization of manufacturing resources. However, the majority of reports deal with the directions only for integrating marketing strategy and manufacturing strategy and fall short of providing any concrete solutions for the exact alignment of such strategies.

In this paper, we focus our analysis on productivity issues, however, the issues of quality improvements are also motivated at appropriate places. Obviously, productivity cannot be achieved without quality improvements and vice versa. For example, if a product is found defective during production, this requires special attention in terms of rework and inspection. This in turn disturbs the normal material flow, and hence an increase in the lead time of other products and reduced productivity. Therefore, productivity and quality should move together to achieve simultaneous improvements.

Table 1 presents the changes that have taken place in recent years in manufacturing organizations towards improving production and quality. This table also emphasizes the need for developing new strategies for improving productivity and quality utilizing new manufacturing concepts and

Table 1
Trends in the manufacturing systems [13]

Environment	Traditional practice	Current practice
Strategic planning	Market orientation	Manufacturing as a competitive weapon, elimination of waste, improved quality, process reliability, emphasis on integration of engineering and manufacturing, flexibility, responsiveness
Basic research and development	Emphasis on product R & D (features, appearance)	Product/process engineering, automated process technologies CAD, GT, CAM, MIS, decision support systems
Marketing	Compete based on certain product features and price, complex forecasting technique, field service emphasized	Compete based on reaction time, quality, reduction of nonvalue-added costs, field reliability is emphasized, flexibility, automation, more product features, increased responsiveness
Product/Process development and maintenance	Two separate and distinct function with little interaction, maximize design criteria, emphasis is on product features, manually engineered, product/process changes costly and slow	Design for manufacturability, integrated product/process development, GT for process planning, interaction with vendors, CAPP, product design for automation, fast response, CIM, close ties between marketing, engineering, and manufacturing
Tooling and Production programming	Dedicated tools, centralized tools, proliferation of tools	General-purpose tools, tools located near point of use, NC, CNC, adaptive control, GT, software support, data base.
Production Management	Complex systems utilized to balance hresources and demand (MRP, capacity planning, infinite series planning), many support personnel required for excessive material handling, and schedule changes, large databases, too much paper work	Fewer support personnel, less detailed transactions, real-time control, expert systems for shop loading, bar code, optical scanners to post production monitoring, paperless systems
In-process material movement	Overall goal is high utilization of machines, large lots, excessive material handling, manual operations, forklifts, in-process storages	Small lots, use of standard containers, cellular manufacturing, few-in-process storage, AGVs, CIM, AS/RS
Production operations	Labor-based, run large lots, creation of demand	Run small lots, triggered by demand, GT, technology-based, integration of all operations, minimize the lead time, process improvement, set-up time reduction
Incoming material control	Many vendors, spread-out locations, large deliveries, selection based on lowest price, customer inspects goods	Few vendors, nearby; close business ties, vendor certification, source inspection, smaller lot deliveries AS/RS, JIT purchasing, electronic links to vendor
Outgoing material control	Build to forecast, stockouts, shipping delays, high inventory cost, distribution systems paper-intensive	Less need for finished good stores because of shortened lead times, build to demand, electronic link with customers
Production quality control	Separate quality control departments, inspection is a discrete operation, quality is "inspected in", allowance for scrap, rework, inspection and return by entire lot	Quality at the source, built-in, totally eliminate defects, worker participation, quality circles, SPC, mistake-proofing, design for inspectability, automation, in-line gauging, zero defects, sensors, CIM.

Table 1 (continued)

Environment	Traditional practice	Current practice
Human resources	Large number of direct workers, manual skilled, labor-productivity	Major education to instil JIT, cross-training, cooperation, quality circles, overlap reduced, better communication, reduced direct labor, multifunction worker, knowledge workers, Computer skills, flatter organizational structure, CIM, CIS
Information systems	Expensive, centralized, long lead time, lack of integration, reliability problems with hardwares	Decentralized, simplified, increased communication needs, MIS, CIM, all systems integrated and on-line, NC code
Facilities management	Layout by function, maintenance as required, centralized support functions, large space for inventory, excessive material handling	GT layout, less space required, flexible facilities, minimal need for inventory storages, layout for automation, focused factory, large support staff
Product service	Complex product design, high warranty costs, quality problems, maintenance of large inventory to support spares, high EOQ	Higher quality, lower warranty costs, shorter lead time, lower EOQ, improved maintainability, Expert systems for spares, higher customer-service levels.

technologies. If we look at the recent trends in manufacturing, automation (FMS, CIM) and quality management (TQM, DFQ, SPC) have played a leading role in improving the system performance by integrating the marketing and manufacturing strategies. Previously, manufacturing organizations have labor intensive production systems, but nowadays the trend is towards more capital intensive equipment, automation, and flexibility focusing on long-term interests. These manufacturing systems, in turn, require knowledge workers as opposed to less skilled workers due to the inherent nature of the advanced production systems. Expert systems (ES) and artificial intelligence (AI) have been in use in automated production systems. Therefore, knowledge workers with special skills in computers and the latest software may improve the performance of the system considerably. The role of research and development is significant in improving the quality of materials used in the products. This supports the quality of products as well as flexibility in processing the products. However, it is imperative to mention that the role of support activities such as trends toward decentralization of maintenance to direct personnel, computer operators, draftsman, and data processors has tremendously grown in recent years and is very important in improving productivity and quality especially in advanced production systems such as JIT, FMS and CIMS. Besides, the TQM concept emphasizes the implementation of preventive maintenance to eliminate defective items completely for improved product quality and productivity.

3. Integration of functional activities for improving productivity and quality

The integration of various functional activities is important from the view of increasing the coordinated effort in producing goods and services. The activities of various functional departments in manufacturing organization and the need for integrating them have been illustrated in Fig. 1.

The conceptual model presented in the Fig. 1 describes how various functional activities are interconnected for producing quality goods and services in manufacturing organizations. There is a clear indication that the earlier practice of productivity and quality improvements has been lacking good strategies from the overall perspectives of the company as it suffered from many disconnected

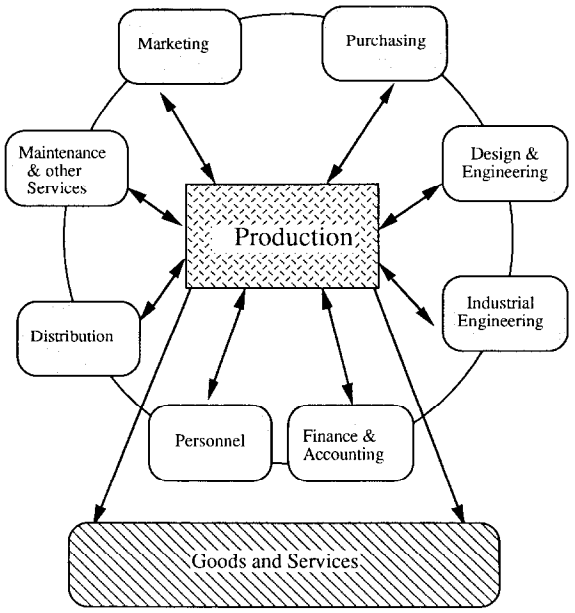

Fig. 1. Interfunctional departments in manufacturing systems to produce goods and services.

objectives among the functional departments and unclear strategies.

As we noted, knowledge workers and support activities play a major role in integrating those functional activities. In addition, new manufacturing concepts (JIT, TQM) and technologies (FMS, CIM) facilitate the integration aspects in manufacturing systems. For example, CIM attempts to integrate the various functional areas such as design, engineering and production using computers. The lead time in the information flow has been drastically reduced in the computerized information system. Moreover, the information is more reliable and in turn reduces the conflicts among the functional departments. JIT also supports the integration between various functional areas using the pull-type production system, strict schedule of production and very close supplier – purchasing relationship. For example, marketing and production must operate without disconnected objectives and strategies. If marketing needs quality products at competitive prices with a view to increase the income, then manufacturing systems should formulate their strategies accordingly. For improving the delivery performance of a product, the production system should adopt a strategy of cost control and efficient production planning. The responsiveness of the system can be increased, for example, by set-up time and inventory level reduction. However, this strategy cannot stand without the cooperation of all other related departments such as marketing, design and engineering and accounting. For example, the design department should provide a correct design that fully incorporates the requirements of customers to engineering and manufacturing. In order to offer a good design that would result in improved productivity and quality, the support of marketing department is necessary in providing more accurate information about customers requirements to the design department. The design department in cooperation with the engineering and manufacturing arrive at the final design parameters. The finance and accounting department evaluates the cost of design and production. This might help the designer to reevaluate the design with a view to produce a cost effective design. Nevertheless, feedback is essential in the production system and the rest of other functional areas about the status of the product and process with a view to improve productivity and quality. In order to facilitate on-line feedback, CIM/CIS may be used as a strategy to improve the communication in the manufacturing organization.

Table 2 presents a set of possible strategies for integrating various functional areas of manufacturing organizations with an objective to improve productivity and quality. The strategies suggested here help to integrate various functional departments easily with an objective of promoting the coordination between them, and increasing the effectiveness of the manufacturing organization as a whole. For example, distribution can implement JIT supplying, JIT transportation, and automated warehousing operations to integrate the distribution activities with other functional areas such as production, finance and accounting, and personnel. Similarly, using CIM, one can easily integrate production with other functional areas such as design and engineering, purchasing, distribution, and marketing. New concepts such as JIT, ZI and TQM and technologies such as FMS, CIM and OPT facilitate an easy integration among various functional departments.

Table 2
A list of suggestions for improving the integration between various functional areas of manufacturing systems

Functional Areas	Strategies for improvement through integration
Marketing	Computerized information systems, QFD, customer's feedback about the quality and reliability of the products, competitors position, and standardization of products
Maintenance	Total preventive/productive maintenance
Distribution	JIT transportation, JIT warehousing, Automated warehousing operations
Personnel	Knowledge workers, flexible work force, and computer professionals
Finance & Accounting	Statistical methods, activity based costing methods
Industrial engineering	Planning and Control, JIT scheduling, TQM and CIM
Design and engineering	CAD, QFD, and concurrent engineering
Purchasing	JIT purchasing, inventory control, and quality at source
Production	JIT, FMS, CIM, OPT and TQM

Traditional concepts of departmental and functional organization do not support flexibility, smooth communication flow, and cooperation. Current technology suggests that lead time and quality problems require team work, including not only manufacturing and engineering but other functions as well [14]. Hence, the nature of the organizational structure that prevents team work from crossing departmental lines should be modified. For instance, if a company is sales oriented, then the manufacturing cannot operate effectively. Alternatively, if the company is a manufacturing-oriented, then the needs of the customer are not considered in the purview of smooth operations. In more recent years the lack of integration between the product design and product engineering function, and manufacturing and manufacturing-process engineering has become an issue of serious concern.

The following three strategic aspects of the company: (i) organization design, (ii) communication, and (iii) reward systems, help the functional integration. Organizational structure should be designed with an objective to promote the integration between various functional areas. Usually top management takes the responsibility of designing the management structure. For the purpose of efficient integration of various functional departments, one should consider mixed structures, decentralized authority, teams, rotation of people through various functional roles, and matrix organizations. The inter-functional effectiveness requires improved communications including: the "protocol" concept, workshops, and finding the optimal decision-making process. The reward systems should reflect concerns of both parties in an internal exchange relationship. The level of joint reward schemes can also be used to influence the effectiveness of integration. Reward systems that are based on (1) a percentage of the profit from products produced less than five years ago, (2) the percentage of initial ideas that reach commercialization, and (3) individual work (e.g. sales) as well as effort within a group that produces a product innovation help to improve the integration. Recent manufacturing technologies enhance interaction between manufacturing and marketing. However, many manufacturing techniques and decision-making tools still do not account for marketing's dynamic nature [15].

The objective aspect of integration is to improve communication and cooperation between the various functional areas involved in developing a product from the point of concept to delivery of the product to the customer. Pegels [16] offered suggestions for integrating various functional areas in manufacturing organizations such as to increase the communication flow and improve the product that will emerge from the development process. He illustrated a highly product development oriented

procedure based on two highly integrated multi-function groups. One group consists of product planning, product styling, market research and budget and finance. The other group consists of product design, product engineering, manufacturing-process engineering, manufacturing, sourcing and suppliers and marketing. There is a number of additional requirements that should be made if functional-area integration is to succeed: (i) top management support, (ii) proper organization structure, (iii) appropriate management control system, (iv) effective incentive and merit system, (v) encouragement by all management levels, and (vi) leadership by all management levels. That is, functional-area integration needs strong top management support. The natural tendency for most functional areas is to concentrate on their own areas of concern. Hence, the organizational culture should be modified in such a way that it includes cooperation and communication in those areas, such as product development, where it is absolutely necessary. Joint programmes, matrix organization, sign-off stages, CAD/CAM, and programme management promote communication and cooperation between functional units (Pegels [16]). Also, integration requires support not only from top management but all levels of management in the company.

The purpose of integrating various functional departments by means of new manufacturing concepts and technologies is to reduce overhead cost which are nonvalue adding items. One of the most frequently suggested methods to reduce overhead costs is automation. Robots can have a role in sophisticated materials control systems that automate logistical transactions; lasers can read bar codes and eliminate the need for data entry operators to record movement transactions manually; computer-aided inspection can help reduce the costs of processing quality transactions; a smoothly running materials requirements planning system can make the processing of balancing transactions cheaper [5]. Support activity or service costs are important especially while employing automation in production, however, these in turn add to the overhead. Therefore, there is a need to reduce the overhead by improving the productivity of the support services such as total preventive maintenance, computer system managers, etc. Most familiar integration is the link between engineering and manufacturing established by CAD/CAM systems, but there are others with equal or greater potential impact.

Total quality management requires us to look at the entire system, seeking new and imaginative ways to improve quality and productivity at the same time. Management of quality consists of quality assignment, quality control, and quality assurance. "Quality assessment" is measuring the level of quality. "Quality control" is action taken during production to avoid or eliminate unacceptable quality. "Quality assurance" includes all activities that eliminate poor quality. This includes quality design of products, processes, and jobs, as well as quality in personnel selection and training. Assessment, control, and assurance all fit together. Assessment is needed for control, which is part of quality assurance. And quality assurance is the goal of the total quality management [17]. The following strategic issues should be considered as a part of total quality assurance with the objective of improving quality of products as well as management: (i) statistical process control, (ii) failure mode and effects analysis, (iii) quality circles, (iv) quality costs, (v) quality improvement process, (vi) quality-related decision making, (vii) quality-related feed back, (viii) quality service action teams, (ix) supplier development, (x) supplier quality assurance systems, and (xi) supplier quality management. Hence, a framework to integrate various functional areas of the manufacturing organization with an objective to improve productivity and quality at the company level would be helpful.

4. Productivity and quality vs. new production concepts and technologies

New production concepts and technologies came into existence out of the effort to integrate various functional areas with an objective of improving the coordination among them for the purpose of improving productivity and quality. For example, nowadays, the main focus is on improving quality. Since quality and productivity are like two sides of the same coin, by improving quality the productivity can be improved and vice versa. The focus

should be design for quality, engineering and manufacturing (DFQ, DFE and DFM). For this purpose, one can use new manufacturing concepts such as JIT and ZI and technologies such as CIM, and computerized information systems (CIS).

Fig. 2 displays the integration of various functional departments using new technologies and concepts of production in a manufacturing organization. The conceptual model presented in the figure reveals the importance of information flows in improving the integration of various subsystems along with the support of new manufacturing concepts and technologies. For example, the gap between marketing and manufacturing can be reduced by JIT production. Since JIT operates on pull type production concept which is essentially starting from the customers' requirements regarding delivery and quality. QFD may facilitate the integration between marketing and design by translating the customer requirements into the design parameters. Similarly, other available technologies such as FMS and CIM and concepts like TQM, and OPT will help to increase the coordination between various functional departments. The OPT can be utilized at the design stage of manufacturing systems for determining the capacity required considering appropriate cost trade-offs. The idea is to achieve the balanced material flow through various stages of the manufacturing organization. This OPT also helps to identify the bottle-neck stages in terms of quality and productivity problems.

Table 3 presents the alignment between business strategy and production strategy using new manufacturing concepts and technologies for improving productivity and quality of the organizations. In addition, selecting productivity and quality improvement strategies are important for improving productivity and quality. For example, if a reduction in the cost of production is desired, JIT might be an option, but not if the market needs a variety of products. Suitable cost accounting systems such as activity based costing (ABC) may be helpful to explore the possibility of assigning joint responsibility among various functional departments.

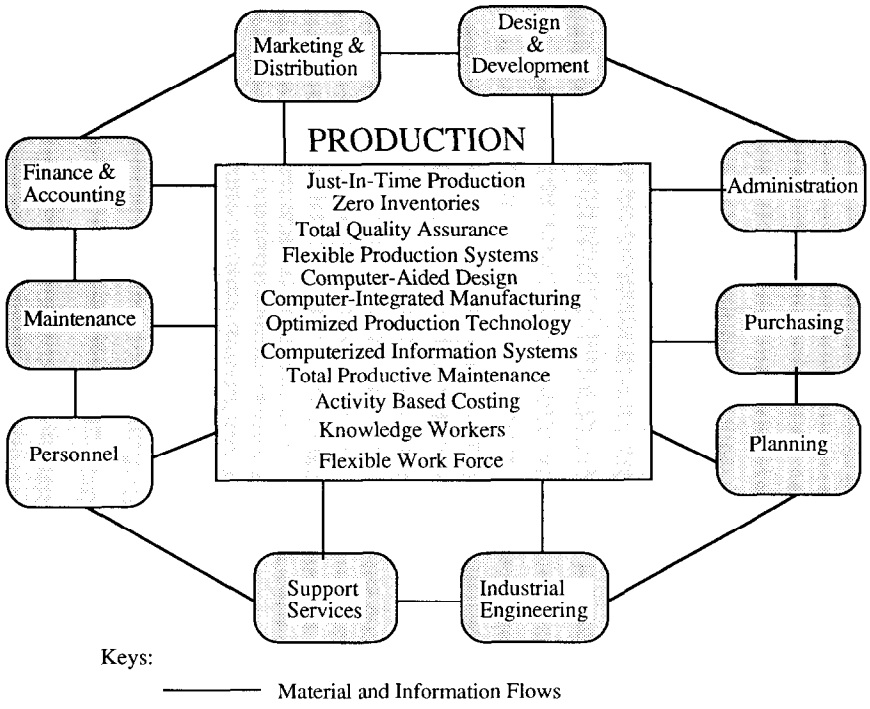

Fig. 2. Integrating functional activities using new manufacturing concepts and technologies.

Table 3
Productivity and quality improvement strategies vs. new manufacturing concepts and technologies

Productivity and quality improvement strategies	New manufacturing concepts and technologies
Improve quality	Concurrent engineering, TQM QFD, CAD, quality at the source.
New products	Flexible production systems, CAD, research and developments
Cost control	JIT, OPT, TQA, FMS, CIM, activity based costing (ABC)

Similarly, new product planning can select a strategy such as flexible production systems or cellular manufacturing systems, CAD, and R & D. Considering the developments and changes in production systems, suitable strategies need to be chosen for improving productivity and quality at the manufacturing level. Manufacturing function works when an organization's facilities, technology, and policies are consistent with the recognized priorities of its corporate strategy. Therefore, organizations should develop productivity and quality improvement strategies which are consistent with and linked to their business strategy. The manufacturing strategy can be characterized by: (i) process structure, (ii) production system, and (iii) organizational objectives. Therefore, suitable productivity and quality improvement strategies are to be determined considering these characteristics of the company.

There is a relationship of strategic significance between quality and the firm's level of productivity. Quality experts reveal that plant utilization to correct bad work may range up to 40% of productive capacity; and that 15–20% of each sales dollar may be supporting expenses resulting from nonconformance to design [18], thus costing the firm's resources and strategic competitive alternatives. The key issues associated with developing a competitive strategy based on achieving high quality are the design of the firm's products and services to meet the customer requirements and the conformance to these designs in the production process and support functions. The link between design quality and business strategy is not well-understood from an integrated basis; neither is the link between conformance quality and strategy. Achievement of conformance quality, on the other hand, requires meeting engineering specifications which are normally clearly specified.

The role of quality within the organization's business strategy must be clearly established, in order to: (1) provide the goals and policies necessary to guide the firm's marketing and management efforts regarding product design, delivery and promotion; and (2) provide the manufacturing strategy necessary to produce products which conform to design, meet cost constraints and are delivered on schedule [18].

The alignment between business strategy and quality improvement strategy is illustrated in the conceptual model presented in Fig. 3. Based on the business strategy of the company, the quality strategy is formulated. The quality strategy is suitably associated with the design and conformance issues. Furthermore, design and conformance issues of the company depends upon the characteristics of the industry, the company's skills and capital available. The design parameters such as output goals and specifications are defined based on the customers' requirements, cost and price of the items, demand for the product, marketing strategy, and competitors strategy. For instance, a company may select QFD as a quality strategy to translate the output requirements into concrete specifications. In case a company selects the quality as the high priority, then the company should choose TQM as a quality strategy to assure quality product and performance. If the company wants to increase the market share by a cost control program, then the company formulates a suitable quality strategy and in turn suitable manufacturing options. From the manufacturing point of view, the quality strategy is associated with product and process specifications, delivery schedules, and cost goals. Based on the customer needs and company ability, the management should establish appropriate product specifications, best delivery schedules, and cost controls. Quality and productivity problems should be resolved prior to manufacturing. If the quality strategy can be translated into conformance parameters, then these parameters meet the quality requirements and hence the business strategy. Now the

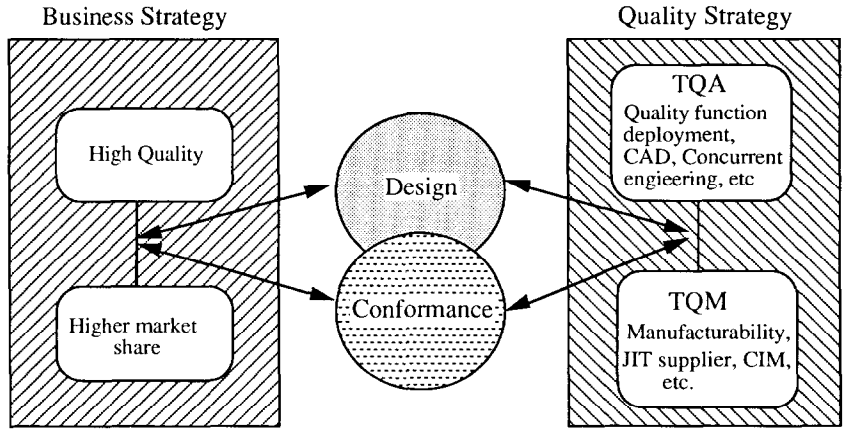

Fig. 3. Business strategy vs. quality strategy.

conformance can be considered as a strategy which emphasizes continuous improvements for eliminating the variances in design specifications and the manufacturing process.

For example, if the business strategy is to capture higher marker share, then the quality improvement strategy can be total quality management or JIT purchasing/supplier systems. Similar inferences can be drawn from Fig. 3. When the product is enriched by good qualities in order to improve the system performance, one can select QFD, CAD, concurrent engineering as a quality improvement strategy. However, depending upon the characteristics such as capital available, nature of the market, location of the company, infrastructure of the company, and the life cycle of the product of the organization, these strategies will differ even for the same business objectives. For example, a company which does not possess sufficient skill, the cost reduction strategy should not be FMS/CIM, rather the company can select a JIT purchasing as a quality improvement strategy. This is due to the fact that FMS/CIM requires knowledge workers and expertise in computers.

JIT purchasing can improve quality. For example, purchasing in small lot-sizes with frequent deliveries will facilitate fast detection and correction of defects. Also, a JIT purchasing system involves a less formal system – which means reduced volume of paper work. This provides more time for the purchasing department to devote to quality matters (Schonberger and Ansari [19]). Future strategic planning will need to: involve more people; focus between the business plan, policy and strategy and the performance improvement plan; be structured, yet flexible and responsive to user needs and preferences; be top-down led with bottom-up implementation; focus on the process plan as well as the plan, be based on knowledge sharing; be seen as a living, on-going process; and, be comprehensive and well-integrated.

5. A strategy formulation for improving productivity and quality

The strategy development process consists of two aspects namely, strategy determination/formulation process and strategy implementation process. The productivity and quality improvement strategies development process is illustrated in Fig. 4. This is based on the strategic management components as suggested by Dess and Miller [20].

The strategic goals of the company depend upon the external factors such as, competitive moves, technological change, demographic, social and government influences, the market, government regulations, general economic conditions, labor unions and political situation, and internal factors such as capital available, skills available,

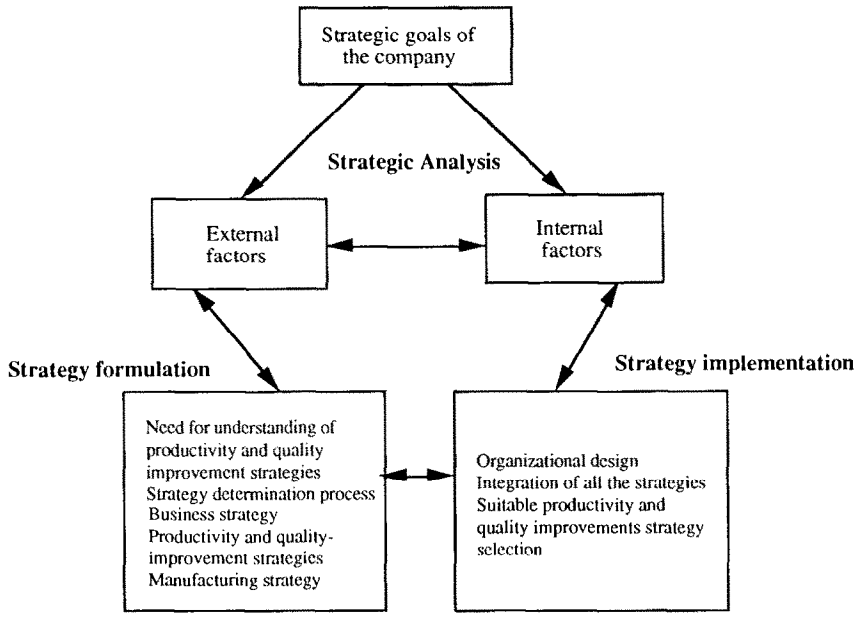

Fig. 4. Productivity and quality improvements strategy development process.

product, production facilities, technology, people, materials, and energy, etc. The main objective here is to achieve success in the business by making use of the available resources productively. Usually, a company decides its business strategy based on both the external and internal factors. The details of the strategy formulation and strategy implementation processes are discussed here below.

There should be a proper understanding of both the business and productivity and quality improvement strategies by management and by all levels of employees. The understanding of the strategy among different people in the company can be achieved only by efficient information flow systems, education and training for all levels of employees who are responsible for productivity and quality. The integration between business and productivity improvement strategy can be obtained by proper documentation, frequent meeting, and international exchange visits. The life cycle of the product should be considered while deciding productivity improvement strategies (Judson [5]). For example, when the product is at the introduction stage, then productivity and quality improvement strategies should be based on the product innovation and flexibility of the production process.

Top management develops the strategy based on external and internal conditions. Middle management then has to work out appropriate productivity and quality improvement programs. The workers, along with middle management staffs, are responsible for implementation. Productivity and quality are the responsibility of everyone in the organization. The help of a consultancy organization can be sought in order to avoid any conflict in the management. There is a need for integrating all strategies with an objective to satisfy the goal of the company as a whole. Integration of strategies need efficient information technology, computers, and software. Also, the nature of the company in terms of product type, market situation, structure of the organization, interfunctional coordination, etc. influence the integration between productivity and quality and business strategies. A variety of options or methods exist for improving productivity. The practicality of each option can be assessed by asking how relevant it is to the business strategy and how easy it is to implement.

6. Strategic options for productivity and quality improvements

In this section, we present some strategic options for improving productivity and quality in manufacturing industries.

(1) The business strategy and productivity improvement and quality strategy should match each other in order to achieve the company's objectives as a whole. For example, when a product is in the decline stage of the product life cycle, then the company can go in for new products. In this case, the business strategy is new products and the corresponding productivity improvement strategy can be a flexible production system. Similarly, one can identify a suitable quality improvement strategy. In case the company does not know the causes for productivity and quality problems in a complex production system, it may want to improve the accounting system. In that case, the company can go for design for quality which seems to be a suitable quality improvement strategy. As another example, strategies such as JIT supplier and quality function deployment (QFD) may be suitable for companies wanting to improve market share and quality. Similarly, cost control requires suitable cost accounting systems, flexible production, and efficient production planning and control. However, as mentioned above, the strategies should be selected taking into account the company's characteristics.

(2) Design suitable computerized information systems to promote easy flow of information between various functional departments of manufacturing systems. As we discussed earlier, computerized information helps to achieve integration between various functional departments. This kind of information system facilitates the exchange of relevant and accurate information between functional departments. In addition to this, computers help to integrate various activities that include integration of various hardware components in manufacturing systems such as material handling, machine tools, and robots. Computer aided design facilitates the design process and possible consequences of various design options using appropriate simulated designs.

(3) When there are problems of low quality and of high defects, one can select 'quality at the source' and 'total quality assurance' concepts for improving quality of the items as well as effective utilization of available resources. Quality function deployment (QFD) and other design approaches are also useful to overcome the problems of quality with a view to satisfy the customers and increase the market share. QFD forces more design (concurrent engineering developments) and development up-front, but ultimately yields greater results.

(4) JIT helps to achieve a reduction in inventory and facilitates fast response to changes in customer's requirements. However, JIT seems to be inflexible; therefore, one might prefer JIT where there is no product flexibility demanded from customers. When the business plan is to reduce the cost of products, the company can go for JIT production, but the inflexibility of JIT systems in terms of changes in products, processes, and accommodating changes in the volume of demand require more careful consideration.

(5) Concurrent engineering developments are necessary when one goes for new products and improvements in process planning and production feasibility. These need to integrate marketing, design and development.

(6) Measurement plays a critical role in quality and productivity management efforts. It provides insight into where change is needed or improvement leverage exists, provides feedback to drive further improvement, and supplies information with which we can assess and evaluate performance. Changes in the competitive environment are causing organizations to reexamine the conventional measurement techniques that have served them well for the better part of the last century. Newer techniques such as total factor productivity measurement, multicriteria performance measurement and cost of quality measurement should be experimented with, studied and implemented.

Sink [21] showed how measurement, planning, and improvement can be integrated

effectively into a strategic management process. Also, nonfinancial performance such as quality and flexibility should be evaluated in order to assess the performance of an organization. Activity based costing can be used for these situations. In addition, a suitable incentive scheme is to be established in order to motivate all levels of employees in the company together with skilled employees and support professionals [22].

(7) The international ISO 9000 series of standards offer guidance for establishing and maintaining a quality system. The achievement of the customer's requirements for the timing, performance and cost of end product should be main objectives of quality improvement plans. The acceptance of quality systems must stem from a department's own realization that the personnel within may be able to improve their performance by exerting a more rigourous control over their internal processes [23].

(8) Total preventive maintenance (TPM) seeks to avoid the six major reasons of production loss: breakdowns, set-up and adjustment time, idling and minor stoppages, reduced speed, process defects, and yield losses. Accomplishing the goals of a TPM program demands total participation by those that impact or are impacted by production equipment. TPM also is an integral part of total quality assurance. This means that quality of the products depends upon the quality of maintenance of equipment and hence the process performed using that machine.

(9) In recent years, the adoption of computer automation has posed problems in tasks such as the software development which require skilled workers. Therefore, suitable steps should be taken to increase software productivity by proper training, and simplifying the process of writing computer programs [24]. Computer technology focuses on providing management information. Information systems are at the core of survival as they offer new competitive opportunities and a strategic advantage. In the future, productivity will come from automating software development through knowledge-based programming. Therefore, attention must be focused on training, increasing skill levels, motivation, and compensation. The compatibility between hardware and software is very important especially when using FMS and CIM, etc for integrating various functional activities. Apart from this, union-management collaboration (the new industrial relations) against the background of contradictory labor relations policies is important in implementing new productivity and quality improvements programs. Cooperation at different levels of management is very important to promote the integration and hence the cooperation between various functional departments involved in a manufacturing company.

7. Concluding remarks

A number of productivity and quality improvement strategies are developed in this paper in line with recent changes in manufacturing environments. Also, from a total strategic view point, a framework has been proposed to improve the productivity and quality by integrating various functional activities. The issues of new manufacturing concepts and technologies while developing strategies for integrating the activities of functional departments in the manufacturing company have been discussed. The cost of quality in terms of profit and loss must be considered because this forms the basis of any effort applied to quality improvements. More productive R & D and integration of R & D with the rest of the company are very important in increasing productivity and quality in manufacturing organizations. The cellular manufacturing system is another means of integrating various functional activities within the production system

Acknowledgements

The authors are grateful to two anonymous referees for their extremely useful and helpful comments on the earlier version of this manuscript which helped to improve presentation of this paper considerably. Also, the authors gratefully acknowledge the financial support by the Neste Foundation.

References

[1] Kurosawa, K., 1991. Productivity Measurement and Management at the Company Level: The Japanese Experience. Elsevier, Amsterdam.

[2] Drucker, P., 1991. The new productivity challenge. Har. Bus. Rev., 69(6): 69–79.

[3] Gitlow, H.S. and Hertz, P.T., 1983. Product defects and productivity. Har. Bus. Rev., (5): 131–141.

[4] Judson, A.S., 1976. New strategies to improve productivity. Tech. Rev., 78(8): 61–67.

[5] Judson, A.S., 1984. Productivity strategy and business strategy two sides of the same coin. Interfaces, 14: 103–115.

[6] Prokopenko, J., 1987. Productivity Management, International Labour Office, Geneva.

[7] Shapiro, B.P., 1977. Can marketing and manufacturing co-exist. Har. Bus. Rev., 104–114.

[8] Starr, M.K., 1985. Productivity as a strategic variable. Interfaces, 15(3): 1–5.

[9] Buzacott, J.A., 1985. Productivity and technological change. Interfaces, 15(3): 73–84.

[10] Rossler, P.E. and Sink, S., 1990. What's ahead for productivity and quality improvement. Ind. Eng., 25–31.

[11] Gold, B., 1985. Foundations of strategic planning for productivity improvement. Interfaces, 15(3): 15–30.

[12] Skinner, W., 1989. Manufacturing: Missing link in corporate strategy. Har. Bus. Rev., 136–145.

[13] Berliner, C. and Brimson, J.A., 1988. Cost Management for Today's Advanced Manufacturing: The CAM-I Conceptual Design. Harvard Business School Press, Boston, MA.

[14] Putnam, A.O., 1985. A redesign for engineering. Har. Bus. Rev., 139–144.

[15] Crittenden, V.L., 1992. Close the marketing/manufacturing gap. Sloan Mgmt. Rev., 41–52.

[16] Pegels, C.C., 1991. Integrating functional areas for improved productivity and quality. Internat. J. Oper. Prod. Mgmt., 11(2): 27–40.

[17] McClain, J.O, Thomas, J.L. and Mazzola, J.B., 1992. Operations Management: Production of Goods and Services. Prentice-Hall, Englewood Cliffs, NJ.

[18] Tillery, K.R. and Rutledge, A.L., 1991. Quality-strategy and quality-management connections, Int. J. Oper. Prod. Mgmt., 8(1): 71–77.

[19] Schonberger, R.J. and Ansari, A., 1984. Just-in-time purchasing can improve quality. J. Purchasing Mater. Mgmt.

[20] Dess, G.G. and Miller, A., 1993. Strategic Management. McGraw-Hill, New York.

[21] Sink, D.S., 1991. The role of measurement in achieving world class quality and productivity management. Ind. Eng., 23(6): 23–28.

[22] Misterek, S.D.A., Dooley, K.J. and Anderson, J.C., 1992. Productivity measure as performance measure. Int. J. Oper. Prod. Mgmt., 12(1): 29–45.

[23] Cornick, T.C. and Barre, N.J., 1991. Quality management and design-build: The opportunities form this method of procurement. Internat. J. Oper. Prod. Mgmt., 8(3): 17–20.

[24] Grammas, G.W. and Klein, J.R., 1985. Software productivity as a strategic decisions variable. Interfaces, 15(3): 116–126.