

***PERFORMANCE MEASUREMENT OF ENABLERS OF COMPUTER INTEGRATED
MANUFACTURING (CIM) IN SMALL AND MEDIUM ENTERPRISES (SMEs)***

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Abstract

Small and Medium Enterprises (SMEs) are the backbone of the industrialization process of many developed countries and play a crucial role in increasing a country's economy. To be able to survive and grow, SMEs must adopt strategic technologies and innovative management to survive. During the last two decades, several factors have forced global manufacturers to make dramatic changes in their products, markets, as well as business and manufacturing strategies. One of the way by which SMEs can achieve a competitive advantage in manufacturing is through the implementation of Computer Integrated Manufacturing (CIM). An attempt has been made in this paper to study the performance measurement of enablers of CIM in SMEs through the empirical study conducted in the province of Sindh in Pakistan.

Keywords: *SMEs, CIM, Performance measurement, Empirical analysis*

INTRODUCTION

Small and Medium Enterprises (SMEs) play an important role in the national economy. Since manufacturing has become global, the competition is high among manufacturing/service industries to provide quality goods and services at competitive prices. The Purpose of CIM is to improve the ability to manufacture and sell products through the utilization of people, land, equipment, raw materials and facilities. CIM is a generic term for a group of manufacturing technologies, which combines, both scope and scale capabilities in a manufacturing environment. The enablers of CIM play an important role in the implementation of CIM by SMEs to compete in the global market. SMEs across the world are implementing CIM. They face growing international competitive pressures combined with the need to interface and integrate

their computer aided design (CAD) systems, numerically controlled (NC) machine tools, robots, and their control system (Caillaud and passemard, 2001). In the world of business, Pakistan is emerging as a developing country to share its value and potential in to the mainstream, although yet to be done a lot so that it could come under the umbrella of developing countries. Agriculture, industry and trade play a significant role in the economic development of a country but the role of advanced manufacturing technologies in the overall development of the country is indispensable. The twenty-first century business environment can be characterized by expanding global competition and products of increasing variety and lower demand (Al-Ahmari, 2002). Today, customers has become more dynamic due to the invention of advanced technologies take both minimum cost and high quality. However, factors like delivery performance and customization and environmental issues such as waste generation are assuming a predominant role in defining the success of organizations in terms of increased market share and profitability (Erenay et al., 2002). To stay in the market place, it is necessary for SMEs to go for automation in general and implement CIM in particular for various reasons such as: *“automated operations not only produce parts at faster rates than do their manual counterparts, but they produce parts with greater consistency and conformity to quality specifications”*. Also, automation allows the manufacturers to reduce the time between customer order and product delivery. This gives the manufacturer a competitive advantage in improving the level of customer service (Dangayach, 2005). This paper presents a brief background of enablers of CIM. An empirical study has been conducted in the province of Sindh in Pakistan to study the performance measurement of CIM in SMEs. Finally, a summary of findings and conclusion is presented.

2. ENABLERS OF CIM USED BY THE SMEs

CIM has been successful in large-scale industries for improving productivity and quality and hence competitiveness of manufacturing .CIM has received little attention from SMEs, although it has an important role to play in improving the competitiveness in global market (Gunasekaran and Thevarajah, 1999). Enablers of CIM are generally defined as *“systems providing flexibility as well as data driven computer integration for a manufacturing organization”*. CIM is a label for a set of techniques that are making fundamental changes to manufacturing industry. The challenge to people in manufacturing SMEs is to understand enough of the technology of CIM to get the best advantage from it without investing unnecessary time or money (Gunasekaran et al., 2000), The reason for studying and implementing CIM is to raise the productivity of SMEs, which in turn will add to the wealth of society and improve the quality of life. High-perceived quality in all aspects of SMEs is now seen as essential to achieve customer satisfaction and international competitiveness. Most manufacturing businesses have quality programs, the objectives of which usually include reducing costs, increasing flexibility and eliminating defects. These are, of course, the classical objectives that would justify the use of enablers of CIM. Enablers of CIM are highly sought by the manufacturing companies to achieve a leading edge in the technology and to

survive in highly competitive markets (Gunasekaran, 2001). Some of the enablers of CIM are as follows:

- Computer Aided Design/Manufacturing (CAD/CAM)
- Computer Aided Process Planning (CAPP)
- Group Technology (GT)
- Concurrent Engineering (CE)
- Flexible Manufacturing Systems (FMS)
- Material Requirements Planning (MRP)
- Manufacturing Resources Planning (MRP-II)
- Electronic Data Interchange (EDI)
- Just-in-Time (JIT)
- Total Quality Management (TQM)
- Robotics
- Internet
- Multimedia

3. EMPIRICAL DATA ANALYSIS

An empirical study of SMEs located in the province of Sindh in Pakistan was conducted using questionnaire. The performance measurement of enablers of CIM in SMEs are discussed with respect to four dimensions that include lead time improvement, decrease in direct labour, improvement in planned delivery schedule and increased productivity. The details follow hereunder:

3.1 Lead time improvement

Reducing lead times for product delivery to the customer is an important business objective for any SMEs. Optimum use of the capabilities of a CIM can make a real contribution to this objective (Marri et al., 1998). An empirical study conducted in different SMEs located in the province of Sindh, Pakistan showed those who have implemented CIM, have achieved significant improvement in their lead time as shown in *Table 1*. 38% of companies indicated lead time improvements to a certain extent. 25% of companies stated that that, they have achieved great improvement in lead times. Further 25% of companies informed that, they achieved some improvement. Only 4% of companies had gained very little improvement in a lead time. While 8% of companies mentioned that none of them had gained or lost in the lead time while implementing CIM in their companies.

Implementation of CIM drastically reduces the lead time from design to sale, and from order to shipment, and WIP inventory, and increases manufacturing productivity, product quality and equipment use. It is therefore clear from the study that, those SMEs who have implemented CIM have achieved great improvements in the lead time.

Table 1: Improvement in lead time

Companies %	A very great improvement	Improvement to a certain extent	Some improvement	Very little improvement	Unchanged
38		√			
25	√				
25			√		
8					√
4				√	

3.2 Decrease in direct labour

In an economy where demand is expanding, the introduction of new technology will be facilitated. As a consequence, production will become more efficient, due, for example, to labour saving or resource saving or both, resulting in lower prices. CIM can be regarded as direct substitutes for semiskilled human labour. Those SMEs who have implemented CIM have achieved more decreases in their direct labour as shown in *Table 2*. During the empirical study, 50% of SMEs mentioned that they had achieved decreases to some extent in their direct labour after the implementation of CIM in their companies. Also, 25% of companies have indicated that, they have reached a great extent of decrease in their direct labour costs. Further, 4% of companies said they have achieved very little decrease in direct labour. On the other hand, 21% of companies achieved no decrease or increase in the direct labour cost after the implementation of CIM in their companies. Overall, those SMEs who have implemented CIM, have achieved some decrease in their direct labour cost. Interestingly, technologies which reduce the direct labour cost are found to have a positive influence on the delivery performance of companies.

Table 2: Decrease in direct labour

Companies %	Decrease at a very great extent	Decrease to a great extent	Decrease to some extent	Very little decrease	Unchanged
50			√		
25		√			
21					√
4				√	

3.3 Improvements in planned delivery schedule

Planned delivery schedule means that work is sequenced according to when it is due for delivery, irrespective of the size of each job or the importance of each customer. Planned delivery schedule sequencing usually improves the delivery reliability of an operation and improves average delivery speeds. International competition in manufacturing industry is increasingly fierce, so that the SMEs that turned to MRP for improved planning and control will now require improvements in their productivity that CIM can provide. Those SMEs who have implemented CIM, their progress in planned delivery schedule is shown in *Table 3*.

Table 3: Improvement in planned delivery schedule

Compa nies %	A very great improvem ent	Improved to a certain extent	Some improvem ent	Very little improveme nt	Unchange d
58		√			
30	√				
8			√		
4					√

During the study, 58% of companies mentioned that, they have to a certain extent achieved improvements in planned delivery schedule after the implementation of CIM. Also, 30% of companies indicated that, they have reached to a great improvement in their planned delivery schedules. Further 8% of companies have achieved some improvements. Only 4% of companies have indicated that they have neither gained nor lost their planned delivery schedule after the implementation of CIM. Overall, those SMEs who have implemented CIM have achieved significant improvements in their planned delivery schedule.

3.4 Increased productivity

At the aggregate level, advances in technology are reflected in manufacturing productivity. Of course, manufacturing productivity has been increasing more or less continuously since the beginning of the industrial revolution. Today in order to stay in business and prosper, manufacturing enterprises are seeking higher effectiveness and competitiveness across the entire cycle of marketing, product design, manufacture, test and sales. An increasing number of them have chosen and are choosing various levels of CIM as the solution. According to Ranky (1990), by implementing CIM, productivity of production operations can be increased by 40-70%. Operating time related productivity can be increased by 2-3 times. Also, the productivity of the engineers and engineering managers can be increased by 5-35 times. Those SMEs who have implemented CIM have achieved a significant increase in their product as shown in *Table 4*.

Table 4: Increased productivity

Compa nies %	A very great increase	Increased to a great extent	Some increase	A little increase	Unchang ed
50		√			
34			√		
8				√	
4	√				
4					√

Based on the result of an empirical study conducted amongst the SMEs who have implemented CIM, 50% of companies have expressed that, they have achieved increased productivity to a great extent. Also, 34% of companies have indicated that, they have reached some increases in productivity. A further 8% of companies informed that, they have managed a little increase in productivity. A at the same time, 4% of companies have quoted that, they have achieved a great level of increase in productivity. 4% of companies informed that, they have not achieved any increases or decreases in productivity after implementation of CIM. Overall, companies who had implemented CIM achieved an increase to a great extent in their productivity.

4. CONCLUSIONS

An attempt has been made in this paper to review the performance measurement of enablers of CIM in SMEs through the empirical study conducted in the province of Sindh in Pakistan. The SMEs have achieved significant improvements in the areas such as: lead time improvement, decrease in direct labour, improvement in planned delivery schedule and increased productivity while implementing enablers of CIM. The survival of SMEs depends upon the increased productivity of their products. The increased productivity will fulfil the demands of their customers and will remain competitive in the global market. It is to be hoped that the adoption of AMT offers the way out of this dilemma by eliminating some of the constraints on capital productivity. The specific mechanisms that can be identified in this connection are (a) sharply reduced inventories of goods and work in progress and, (b) sharply increased output per machine, via increased operating speeds and increased utilization rates.

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