

Factors Influencing The Success Of Technology Adoption: A Case Study Of Indonesian Manufacturing Firms

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ABSTRACT

To date, the role of technology management as a factor of success in technological innovation has been a subject of significant interest among practitioners and academicians. Despite the plethora of attention given to the numerous issues of management of new technology adoption and implementation, many organizations still fail to manage their technology efficiently, effectively, and strategically. This paper is based on a field investigation via face to face interviews with top management in East Java involving medium and large manufacturing companies from the tobacco, plastic, pulp, furniture, textile, cable and plywood sectors.

This research seeks to investigate the extent of technology adoption and its management in medium and large Indonesian manufacturing companies. Further, this study investigates the technology benefits perceived by respondents. The study found that: (1) Indonesian manufacturing companies still lack a strategic perspective when adopting technologies and they are more concerned with short-term issues; (2) they face problems related to people, organizational issues, limited budgets and lack of government support; (3) these problems limit the choice of technologies and together with the national economic situation, reinforces the short-term mindset of top management. In addition, the investigation of critical success factors and inhibitors of technology adoption is necessary for identification of a proper vision and strategic viewpoint of managing new technology.

Keywords : technology adoption, manufacturing, East Java, medium/large industry.

ABSTRAK

Sampai sekarang, peranan manajemen teknologi sebagai factor keberhasilan dalam inovasi teknologi menjadi topik yang menarik perhatian para praktisis maupun akademisi. Walaupun masalah-masalah manajemen teknologi dan implementasinya telah banyak diperhatikan, masih ada banyak perusahaan yang belum mampu mengatur teknologi secara efisien, secara efektif atau dengan strategi yang tepat. Makalah ini dibuat berdasarkan survei lapangan yang menggunakan wawancara langsung dengan para manajer atas di Jawa Timur dari perusahaan manufaktur besar dan menengah dari sektor rokok, kertas, mebel, tekstil, kawat, dan kayu lapis.

Penelitian ini bertujuan untuk menyelidiki sampai sejauh mana teknologi telah diadopsi dan juga cara mengaturnya di perusahaan manufaktur yang menengah dan besar di Indonesia. Lebih lanjut, penelitian ini ingin mengetahui persepsi responden tentang keuntungan yang diperoleh dari teknologi. Penemuan penting: (1) perusahaan manufaktur di Indonesia masih belum mempunyai pandangan strategic

terhadap adopsi teknologi and menjadi lebih berfokus pada masalah-masalah bersifat jangka pendek; (2) ada masalah terkait dengan sumber daya manusia, masalah organisasi, anggaran yang kecil, dan tidak didukung oleh pemerintah; (3) masalah-masalah tersebut menjadi kendala dalam memilih teknologi dan bersama dengan keadaan ekonomi nasional menyebabkan para manajer mempunyai pandangan jangka pendek. Selain itu, penelitian tentang faktor-faktor kritis yang membawa keberhasilan dan juga faktor-faktor yang menghambat adopsi teknologi harus ditentukan agar visi dan pandangan yang tepat terhadap teknologi baru dapat disusun.

Kata kunci: *adopsi teknologi, manufaktur, Jawa Timur, industry menengah/besar.*

INTRODUCTION

In the last decade, more and more business organizations have invested in new technology, advanced technology, computer-based technology, and also adopted new processes and products to survive and to stay competitive. The increased degree of interest and investment in technology has made research and investigation of the factors related to the adoption of new technology and how business organizations manage technology adoption particularly interesting for researchers.

The word 'technology' usually conjures up many different images and generally refers to what has been described as the high-tech industries. However, limiting technology to these kinds of industries such as computer based technology and advanced manufacturing technology and to science, mathematics and engineering loses sight of other supporting technology. There is no limit to the way in which organization can describe technology, only that the organization defines what they mean by technology (Gaynor, 1996).

A number of researchers have studied the factors that influence the successful adoption and implementation of new technology. Raymon and Bargeon (1998) conducted a descriptive analysis comparing small and medium companies in determining the success factors of business process re-engineering. Yan and Ning (1997) looked at factors affecting innovation, while Udo, et al. (1995) investigated determinants of advanced manufacturing systems. Iacovou and Benbasat (1995) conducted a case study on factor influencing the EDI adoption practices.

It is widely accepted that technology is a resource that is not only important to operations but also to corporate profitability and growth as well. Maidique and Patch (1988) argued that technology is a critical force for the business organization in a competitive environment. Similarly, Morone (1989) viewed technology as a source of competitive advantage. Stacey and Aston, (1990) highlighted that technology advancement played a vital role in long term profitability, and Higgins, (1995) identified technology as a contributing factors to successful operations. These phenomena indicate that technology has transcended beyond its traditional administrative support role toward playing a more central part of business strategy. Technology is now viewed as a strategic weapon to achieve sustainable competitive advantage and support the competitive strategy of the firm.

The success of technology adoption, technology implementation, and empowerment of technology as competitive advantage depend on how the organization manages the technology. Managing technology is related to how the organization generates the

technology internally, develops technology externally, then integrates the technology within operational activities, including how the organization manages the existing skilled and operational workers (Morone, 1989).

The concept of technology management covers not only R&D but also the management of product and process technology. Viewed from that perspective, management of technology is actually the practice of integrating technology strategy with the business strategy in the company (Betz, 1993). Effective management technology links engineering, science, and management disciplines to address the issues involved in the planning, development, and implementation of technological capabilities to shape and accomplish the strategic and operational objectives of organization. Management of technology provides firms with many opportunities for improving performance although the cost of entry requires, among other things, ignoring the quick fixes promoted by the latest management guru.

In the case of Indonesia, there is a dearth of information or empirical research relating to the adoption of technology by Indonesian manufacturing firms. Thus, it is interesting to conduct a case study on technology adoption and management, to investigate the critical success factors and the inhibitors in the technology adoption process. This study is an initial study that hopefully can be used to guide and to give direction to other Indonesian researchers concerned with the technology management area.

OBJECTIVES OF THE CASE STUDY

In view of the background and the corresponding literature review, this case study incorporates the following objectives:

- To identify the general objective of the firms adopting and implementing technology.
- To identify the external and internal driver motivating and influencing technology adoption.
- To identify the type of hard technology and soft technology that have been adopted and to find out whether hard technology or soft technology is more dominant to achieve competitive advantage in Indonesian manufacturing firms.
- To identify the key success factors and the barriers in managing technology adoption.
- To find out how the firms develop their technology capability, and what is the result of technology adoption and technology implementation.

RESEARCH METHOD

There are many approaches to studying technology adoption management. Researchers have employed questionnaires to study technology adoption, implementation and organizational performance (Schroeder and Sohal, 1999; Sim, 2001; Koo, et. al. 2000; Burgess, et all, 1998). The use of interviews by Doms, et al. (1994) suggests that technologies complement human capital. Other researchers conducted case studies to investigate technology adoption, implementation, and performance (Butcher, et al., 1999; Harrison and Samson, 1997).

This study uses the modified version of the Processual Model that was developed by Dawson (1994). Importantly, this model was used as a guideline to investigate the experiences of business organizations in adopting and implementing technology. Figure 1 presents the framework for analyzing those factors that can influence new technology adoption success.

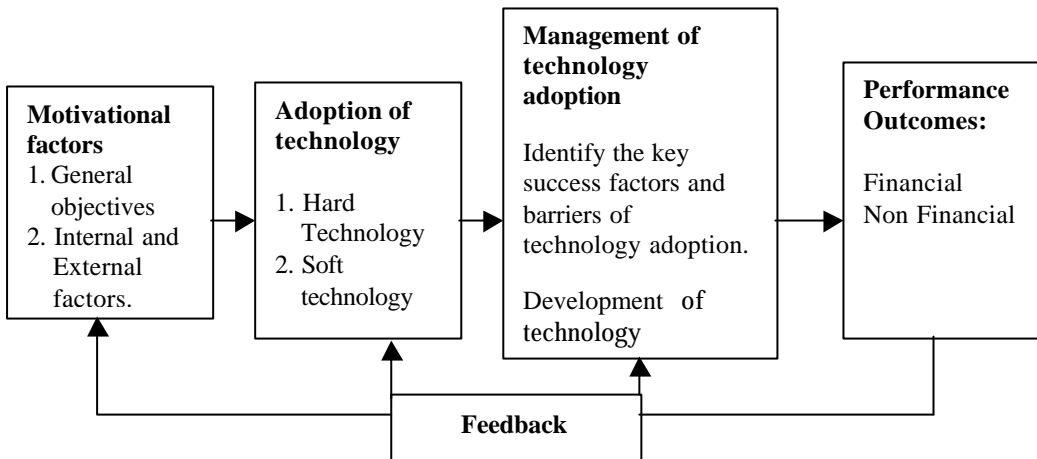


Figure 1. Framework of The Process of Adoption of Technology

For this study, a list of medium and large companies was obtained from the Directory of Manufacturing Industry, published by the Indonesia Statistic Center Bureau (Badan Pusat Statistic Indonesia, 2000). Seven companies were chosen at random from the manufacturing sectors, located in East Java. Data were collected through face-to-face interview with top-level management by using a *semi-structured questionnaire*. The duration of the interview was about two hours in order to get all the information needed for this study. Classification of the sized of the firms was based on the number of employees: (1) firms with 10-99 employees are classified as small. (2) Firms of 100-499 employees are classified as medium and, (3) firms over 500 employees are classified as large. This classification technique was undertaken by past researchers such as Ko, Kinkade, and Brown, (2000) and also Cagliano and Spina (2000).

As shown in table 1, the profile of companies that are participated in this study included the field of business operations, length of operations, number of permanent employees, assets, and the general performance in past three years. The seven chosen companies operate in different field of business, consisting of tobacco, plastic, pulp, furniture, textile, cable, and plywood. All of the companies are private companies that have been operating for more than ten years.

Table 1. Respondents' Profile

Company	Kind of Industry	Length of Operation	Number of Employees	Assets (Billion Rp)	Ownership	Performance: last three years
1.	Tobacco	> 30 years	24.000	> 100 Bil	Private	Increase > 0.15
2.	Plastic	> 10 years	330	> 75 Bil	Private	Increase 0.10 - 0.15
3.	Pulp	> 10 years	7.274	> 100 Bil	Private	Decrease 0.05 - 0.10
4.	Furniture	> 10 years	200	> 100 Bil	Private	Increase 0.05-0.10
5.	Textile	> 10 years	2.981	> 100 Bil	Private	Decrease > 0.15
6.	Cable	> 20 years	629	> 100 Bil	Private	Increase 0.05 – 0.10
7.	Plywood	> 20 years	2.367	> 50 Bil	Private	Increase > 0.15

FINDINGS

General Objectives and Factors Influencing technology adoption

Table 2 below indicates the general objectives for adopting technology. Given the recession and keen competitive environment, it was not surprising to note that all the respondents cited enhancing competitive position as the primary objective. This is followed by 'improving product and process quality' and 'improving productivity' level.

Table 2. General Objectives of Technology Adoption and Technology Implementation

General objectives	Company							Percentage (%)
	1	2	3	4	5	6	7	
Enhance competitive advantage	x	x	x	x	x	x	x	100
To improve product and process quality	x	x		x	x	x	x	85.7
Increase productivity	x	x		x	x	x		71.5
To meet customer demand	x	x				x		42.8
Delivery capability		x			x		x	42.8
Increase profitability	x		x					28.6
To extend the market.		x					x	28.6
Cost reduction.		x						14.3
Survival		x						14.3
Competitive price.		x						14.3
Product development.		-				x		14.3
Process development		-				x		14.3

x : General objective of technology adoption and technology implementation

Adoption and implementation of technology consequently demand the companies to change the organizational culture, organizational system, as well as the human resource management practices. In addition, the companies also face business competition by making various changes within the company. There are many factors driving the companies to adopt technology, both internally and externally. The external factors include: 1) global competition; 2) increasing customer demand for quality products; 3) the changing economic conditions that cannot be predicted; 4) higher market pressure; 5) environmental sustainability; 6) the degree of competition in local market; and 7) media

coverage. Internal factors include: 1) implementing technology strategy; 2) increasing material costs of production; 3) increasing operational costs; 4) increasing business costs; 5) obsolescent plants and equipment; 6) increasing labor cost; 7) decreasing profits; 8) decreasing quality of products; and 9) high *labor turn over*. Further, this study finds that the major external drivers are global competition and the customer demand for quality. All seven respondents cited these two factors as the primary drivers for technology adoption. Internally, two major drivers of technology adoption are the need to implement technology strategy and the increasing material cost.

Table 3. External factors Driving Technology Adoption

External factors	Company							Percentage (%)
	1	2	3	4	5	6	7	
Global competition	x	x	x	x	x	x	x	100
Customer demand for quality	x	x	x	x	x	x	x	100
Change in economic condition	x			x		x	x	57.1
Higher market pressure.		x		x	x	x		57.1
Environment sustainability	x		x	x			x	57.1
Competition in local market	x	x				x		42.8
Media attention.	x			x				28.5

x: external driver of technology adoption.

Table 4. Internal Factors Driving Technology Adoption

Internal factors	Company							Percentage (%)
	1	2	3	4	5	6	7	
To implement technology strategy	x	x	x	x	x	x	x	100
Increasing material cost	x	x	x	x	x	x	x	100
Increasing labor cost		x		x		x	x	57.1
Increasing the business cost		x		x	x	x		57.1
Plant and equipment obsolescence				x	x	x		42.8
Increasing operational cost.				x	x	x		42.8
Decreasing profit				x		x		28.5
Decreasing quality of product		x				x		28.5
Labor turn over is high.						x		14.3

x: internal driver of technology adoption.

Hard and Soft Technology Adopted

To face and/or overcome various problems such as the increasing degree of competitiveness and the more hostile of environment, companies try to survive and stay competitive by adopting and implementing technology and new management practices. Tables 5 to 10 describe technologies that have been adopted by the companies in this study.

Technology adopted can be categorized as hard (those relating to facilities, equipments, robotics and computer aided-manufacturing) or soft (those relating to managerial systems) such as total quality management (TQM), just in time (JIT), total

productive manufacturing (TPM) and others. In terms of hard technologies, the level of sophistication of technology adoption is moderate, covering technologies such as CNC machines, updating process equipment (UPE), and computer aided design (CAD). Only two of the respondents indicated their use of more sophisticated technologies such as robotics and automated guided vehicles (AGV). This is largely due to the lack of expertise to maintain and operate sophisticated technologies, apart from the lack of funds to invest in such technologies, which are typically very expensive.

Table 5. Hard Technology Adopted

Hard technology	Company							Percentage (%)
	1	2	3	4	5	6	7	
CNC	x	x	x	x	x	x	x	100
APE	x	x	x	x	x	x	x	100
CAD	x	x	x	x	x	x		85.7
AA	x	x	x	x			x	71.4
FMS	x	x	x	x			x	71.4
CAM	x	x	x	x			x	71.4
CAE	x		x	x	x		x	71.4
SFMC	x	x			x	x	x	71.4
FMC	x		x	x			x	57.1
CAPP	x	x	x	x				57.1
AMHS			x	x			x	42.8
AGV	x		x				x	42.8
Robotic		x				x		28.5
X : technology that has been adopted. APE : Updating process engineering (7) CNC : Computer numerical control (7). CAD : Computer Aided Design (6) CAM : Computer Aided Manufacturing (5) FMS : Flexible manufacturing system (5) CAE : Computer Aided Engineering (5) SFMS: Shop floor monitoring and control by computer (5).				AA : Automated assembly (5) CAPP : Computer Aided process planning (4). FMC : Flexible manufacturing cell (4). AMHS: Automated material handling system (3). Automated Guide Vehicle (3). Robotic (2).				

Table 6 shows that soft technologies like TQM, JIT, MRP2, TPM and Benchmarking are pervasive. This ties in with the major internal driver, namely the customer demand for quality. The focus on soft technology is largely due to the lower initial investment involved. To face or overcome various problems such as increasing degree of competitiveness and the more hostile environment, companies try to survive and to stay competitive by adopting and implementing technology and new management practices.

Based on the results of this survey, Table 7 shows that only one of the seven companies balanced hard technology and soft technology to achieve operational excellence, while the other six companies adopted more soft technology.

Tabel 6. Soft Technology Adopted

Soft Technology	Company							Percentage (%)
	1	2	3	4	5	6	7	
TQM (Total Quality Management)	x	x	x	x	x	x	x	100
JIT (Just In Time)	x	x	x	x	x	x	x	100
TPM (Total Productive Maintenance)	x	x	x	x	x	x	x	100
MRP2 (Manufacturing Resources Planning)	x	x	x	x	x	x	x	100
Benchmarking	x	x	x	x	x	x	x	100

Tabel 7. The Role Hard Technology Vs Soft Technology

Type of technology	Company							Percentage (%)
	1	2	3	4	5	6	7	
Soft technology	x	x	x	x	x	x	x	100
Hard technology	x							14.3

Company 1: Balancing between hard technology and soft technology.

In relation to the extent of adoption, a number of issues experienced by the companies during the adoption and implementation stages were raised by the respondents. Each company has different issues during adopting and implementing technology. Issues raised revolve around operational problems. This indicates a lack of strategic perspective when adopting and implementing new technologies even though competition and customer demands are the primary drivers. Table 8 below presents the issues raised.

Table 8. The Issues Raised During Adoption and Implementation of Technology

Company	Issues
1.	<ul style="list-style-type: none"> • Same contribution of hard technology and soft technology. • Adoption of hard technology performed to achieve efficiency and stabilization of operational process. • Adopt supply chain management and integrated business information systems related with sales, material purchasing, inventory and financial.
2.	<ul style="list-style-type: none"> • Lack of cooperation with supplier. • Eliminate all not value added activities.
3.	<ul style="list-style-type: none"> • Organizational problems (conflicts and centralization) become barriers to optimizing benefits of technology.
4.	<ul style="list-style-type: none"> • Build solid team-work, encourage participation and involvement of workers during adoption and implementation of technology. • Adoption of AMT purposed for creating value added of product and developing new designs.
5.	<ul style="list-style-type: none"> • Because of functional problems, the company tries to survive with existing technology (plant, equipment, and machine).
6.	<ul style="list-style-type: none"> • Lack cooperation with customers and suppliers. • No formal technological planning.
7.	<ul style="list-style-type: none"> • Emphasis on continuous improvement of technology. • Learning from success of other companies through benchmarking.

Critical success factors and inhibitors during technology adoption

Table 9 reports the factors that respondent felt were critical to the success of technology adoption and management, while Table 10 lists the factors that inhibit success. Successful technology adoption and implementation require key success factors such as the openness of innovation culture in all management levels and in the whole organization, top management support and involvement, monitoring systems toward adoption and implementation regularly, the availability of resources that support technology adoption, an open communication system both vertical and horizontal, cross-functional working system, employee evaluation, personal employee selection, involvement or participation from all workers, clear direction in planning and the degree of investment in R&D.

It is clear that most of the factors are clustered around: 1) top management (support and involvement); 2) culture (openness of innovation, participation, cross functional working system, open communication system); 3) strategy (technology sourcing, monitoring systems); 4) skill development (employee training and education); and 5) resources (availability of finance, materials and technocrats).

Table 9. Critical Success Factors As Reported By Respondents For Managing Technology Adoption

Critical success factors	Company						
	1	2	3	4	5	6	7
Openness innovation culture.	x		x	x	x	x	x
Top management support and involvement.	x	x	x	x	x	x	
Monitoring system.	x	x	x	x	x		x
Avaiability of resources	x	x	x	x		x	x
Open communication system.	x		x	x	x	x	x
Cross functional working system	x	x	x			x	x
Employee evaluation	x	x					
Employee selection				x			
Clear and systematic direction in planning	x						x
Participation of all worker	x	x		x			
Investment in R&D	x						x

When implementing the new technology, our respondents encountered major difficulties in the form of skill shortages, the need for training and outsourcing maintenance, and the lack of financial sources. Another important inhibitor identified by respondents is the lack of government support, related to investment or policy on technology. As the study was conducted during the economic recession, it is not surprising that these factors were considered as significant inhibitors. Other inhibitors identified include departmental and personal conflicts and resistance to change.

Table 10. Inhibitors to Successful Technology Adoption

Inhibitors to Technology Adoption	Company						
	1	2	3	4	5	6	7
Lack of skilled worker			x	x	x		x
Cost		x	x	x	x	x	x
Conflict		x	x	x		x	x
Resistance to change			x		x		
Recession.	x	x	x	x	x	x	x
Slow technology transfer.			x		x		
Availability of budget	x				x		x
Inadequate skill implementation		x		x	x		
Lack of government support.	x	x	x	x	x	x	x
Lack of strategic perspective					x		

Technology Capability Development

Technology capability is as important as other functional capability in organizations, particularly as a competitive weapon. Technology capability can be used as a strategic tool for developing products and processes, expanding market share, and increasing profitability, provided that technology is integrated with all the functional capability of the company (Harisson and Samson, 1997). As presented in Table 11, this study suggests that not at all companies have integrated technology capability with functional capability. This evokes failure of adoption and implementation of technology and the technology cannot give expected results.

Table 11. Integration Between Technology Capability with Other Functional capabilities

Integrated/ Not integrated	Company							Percentage (%)
	1	2	3	4	5	6	7	
Yes	x		x	x	x		x	71.5
No.		x				x		28.5

Development of new capability of technology has to be done continuously because technology expands and changes rapidly. Based on respondents' experiences, they develop technology in many ways:

- Introducing new technology that is important to be adopted and to improve the technical and operational capability of organizations.
- Enhancing skills, knowledge, and abilities of employee through training and educational courses.
- Improving and changing organizational culture. (This case study highlights that a centralization ideology is more dominant in Indonesian companies).
- Creating innovative culture that encourages participation and involvement of workers, so that technology capability can be improved.
- Enhancing collaboration with suppliers.
- Enhancing relationship and collaboration with customers.
- Collaborating with other companies, even with competitors, through benchmarking.

Table 12 below describes the nature of technologies adopted by each respondent. Adoption decisions are normally made based on the urgency of the technology, taking into consideration the availability of budget, preparation for adoption, implementation and anticipation of the accompanying risks and difficulties. The technologies adopted are largely those related to plant and equipment, computer hardware, computer software, and new management practices and techniques.

Tabel 12. Development and Adoption Of New Technology

Respondent	Introduction and Development	Respondent	Introduction and development
1.	Plant Equipment Computer hardware Computer software Apply new management practice.	4.	Plant and equipment Computer hardware Computer software New management practices.
2.	Plant and equipment Computer hardware Computer software New management practices.	5.	Apply new management practices
3.	Plant and equipment Computer hardware Computer software New management practices.	6.	Plant and equipment
		7.	Plant and equipment

Much literature has been studied, discussed, and presented (conceptually and empirically) about benefits and advantages obtained after adopting and implementing technology. Table 13 shows performance outcomes after adopting and implementing technology. Each company obtains different benefits after adopting various technology, both hard and soft technology.

Tabel 13. The Performance Outcome Achieved by Companies After Technology Adoption

Company	The result of technology adoption
1.	<ul style="list-style-type: none"> • Reduced production cost. • Reduced process cycle time. • Increased capability of delivery time • Reduced product defect. • Increased labor productivity • Efficiency. • Improved working environment • Increased sales
2.	<ul style="list-style-type: none"> • Reduced time of production process • Increased productivity. • Delivery capability • Eliminated waste of material and energy. • Improved production controlling. • Reduced inventory of work in progress product. • Reduced overhead cost. • Solved technical problems.

3.	<ul style="list-style-type: none"> • Reduced time of production process. • Better management control, to make management control easier.
4.	<ul style="list-style-type: none"> • Reduced time to process. • Improved the capability of product delivery. • Reduced product defect. • Improved the capability to develop product design • Increased market share • Increased productivity
5.	<ul style="list-style-type: none"> • Reduced product defect • Stabilized production process • Reduced cycle time of production
6.	<ul style="list-style-type: none"> • Reduced cost of production • Reduced average cycle time of production • Improved delivery time capability • Improved product quality. • Increased productivity • Eliminated waste • Increased flexibility
7.	<ul style="list-style-type: none"> • To defend from the hostility of business environment • Improved working environment. • Overcame skills deficiencies. • Improved response to customer demand.

CONCLUSION

Findings from this case study conclude that first, Indonesian companies still lack strategic perspective when adopting technologies, they are more concerned with short-term drivers, their sources of ideas for technology are internally focused and do not include suppliers and marketing. Further, the culture of 'management knows best' leads to low involvement by all parties.

Secondly, this study suggests that participation and involvement of employees is still very low, so the companies need to encourage employee involvement and to create innovative culture. In managing adoption of technology, key success factors are needed and barriers have to be overcome.

Thirdly, technologies that are dominant are related to process technologies and those that can be classified as soft technologies. Benefits of technology from respondents clearly are limited to operational efficiency measures. This is the reason for domineering role of top management, production and engineering in idea generation, decision-making and monitoring of the technology implementation projects.

Fourthly, the importance of developing technology capability continuously such as introducing new technology, enhancing technological skills and capabilities of employees, and also creating culture that encourages technology advancement is highlighted.

Finally, the above scenario can be attributed to two major factors – the lack of technical expertise and the lack of funds for investments. The latter limits the choice technologies and together with the economic scenario of the nation, it enforces a short-term mindset of the top management.

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