A STUDY ON TECHNOLOGY MANAGEMENT PROCESS: THE PARTS AND COMPONENTS SUPPLIERS IN THE TURKISH AUTOMOTIVE INDUSTRY

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ABSTRACT

This paper summarizes part of an empirical study on technology management process in the Turkish automotive parts and components industry. In this study, technology management practices in the Turkish automotive parts and components suppliers' sector are described and evaluated. Practices, techniques, and approaches are proposed to improve the level of technology management so as to turn technology into a competitive weapon. The investigation is organized within the framework of a *process model for technology management* that consists of technology identification, selection, acquisition, exploitation, protection, and abandonment. A comprehensive questionnaire addressing all phases of this process is developed and the results of 21 companies are presented.

KEYWORDS: Technology management process; Modelling; Business and technology strategies; Automotive industry; Suppliers; Empirical research.

INTRODUCTION

This paper is a summary of parts of an empirical study on technology management process in the Turkish automotive parts and components industry [1]. The study has been sponsored by the Turkish Industrialists' and Businessmen's Association (TÜSİAD) and carried out with the cooperation of the Association of Automotive Parts and Components Suppliers (TAYSAD).

In this study, technology management practices in the Turkish automotive parts and components suppliers' sector are described and evaluated. Practices, techniques, and approaches are proposed to improve the level of technology management so as to turn technology into a competitive weapon.

Automotive industry is a global industry constituting a significant proportion of global industrial production and international trade. In 1998, the worldwide production amounted to 53.7 million motor vehicles comprised of 38.5 million automobiles and 15.2 million commercial vehicles [2]. In 1997, the global exports of motor vehicles reached 20.3 million representing an annual increase of 11.7% over the previous year [3]. In monetary terms, this equals to an amount of 500 billion USD and represents 10.5% of global exports. It is estimated that the exports of vehicle components amounts to 500 billion USD.

Automotive industry is in a specific phase of its evolution. It is possible to observe the dominant design of car among the offerings of various manufacturers. There exist minor differences among the vehicles of the same category. Ealey and Bermudez [4] suggest strategies that can be used to build brand image and perceived value and to avoid the transformation of automobiles into a commodity. Price is the principal basis of competition in the majority of market segments.

The recent mergers and acquisitions in the automotive industry lead to a decline in the number of manufacturers. This trend is expected to continue. Most of the manufacturers start to develop global manufacturing and distribution strategies. One such strategy is to dedicate a certain plant to the manufacturing of a particular model. This creates the opportunity to maximize the productivity and efficiency of these plants through specialized equipment and long production runs.

These developments have obvious implications on suppliers. The number of suppliers declines, too. There were 30,000 parts suppliers through the world in 1988 and only 4,060 survive today. Within the next five years, it is expected that 26 truly global supplier companies will dominate the industry [5]. Vehicle manufacturers give larger contracts to fewer suppliers. This allows the suppliers to make volume savings and to install specialized equipment, the cost of which can only be justified over a long production run.

Despite the higher costs incurred in both R&D and in the manufacturing of better quality components, the suppliers are forced continually to reduce their prices. Most contracts issued by the vehicle manufacturers for components incorporate price reduction clauses [6].

In Turkey, the automotive industry is the third biggest manufacturing sector. Twenty one companies operate in the sector. Except for one tractor manufacturer all other companies manufacture under foreign licenses. In 1997, the total amount of sales was 5.6 billion USD equaling a total of 400,000 vehicles. The total number of employees is about 30,000.

Automotive suppliers sector is an integral part of the automotive industry. At present, there are approximately 1300 Turkish automotive supplier companies employing approximately 50,000 people. The total amount of sales for 1997 was 3.9 billion USD.

TAYSAD is the principal representative of the sector. It has around 170 member companies that employ 35,000 people.

In a relatively short time and at a high pace, Turkey found herself in global competition. The requirements of global competition on the industry have been quite challenging and they are guiding the business strategies of the companies. Developing competence in product and production technologies stands out as a candidate for becoming a major competitive advantage. Hence the management of technology is a field that attracts increasing attention in the last years in Turkey.

In the literature, numerous approaches for the management of technology are discussed. These models aim to provide a structure positioning technology strategy into the overall framework of competitive strategy. With the technology intensity increasing in all sectors of the economy, the successful integration of technology planning with business planning gains in importance for business success. One of the five technology planning best practices reported by Metz [7] is to establish a structured process for technology planning.

The process model proposed by Probert and Gregory [8] for organizing technology management activities is taken here as the core model around which this study is built. It is indeed appealing to employ a process model since it is expected that in near future, process-based organizations will become widespread [9]. The model considers technology management as a *process* including the sub-processes of identifying, selecting, acquiring, protecting, and exploiting technologies.

[Insert Figure 1 about here]

METHODOLOGY

The methodology is designed to evaluate the current level of technology management process and the extent of support provided by proper technology and business strategies within the companies. The technology management process model includes the processes of technology identification, technology selection, technology acquisition, technology exploitation, technology protection, and technology abandonment (Figure 1). Although the model might appear to be linear, it is not meant to be linear. There are different feedback mechanisms and interactions among the different processes.

Given a technology strategy has been formulated at the company level, the technology management process follows the guide path set out by that technology strategy. This shows how crucial it is for a company to have developed its own technology strategy for proper technology management. Due to the strong interaction between the business and technology strategies, the technology management process cannot be isolated from the business strategy. Thus the research reported here is not restricted to the technology management process only but also includes aspects of business and technology strategies.

The Questionnaire

A comprehensive questionnaire addressing all phases of the study is developed. Individual subheadings within the questionnaire are as follows. The number of data to be provided and selections to be made under each subheading are provided in parentheses following the subheading: Company profile (48), business and technology strategy (29), technology identification (55), technology selection (52), technology acquisition (73), technology exploitation (27), technology protection (16), technology abandonment (50), results from introducing new technologies (20), barriers to the successful execution of the technology management process (43). The items asking the respondent for a selection are derived from the best practices reported in the literature. The respondent answers from among three choices provided. The information gathered from the respondent are typically on an ordinal scale.

The Sample

The study encompasses a sample of 25 companies decided upon jointly with TAYSAD. The companies are selected by considering the subsector they are in and their annual turnovers. The subsectors considered are electrical components, metal removing, casting, forging, brake systems, seating, and instrumentation. In each subsector, four or five companies with the highest turnover were selected. The companies participating in the survey realize around one third of the sales and two thirds of the exports of TAYSAD members. Since the first objective of this study is to describe and evaluate technology management practices in this sector, it appears to be reasonable to include in the sample only those companies which have relatively sufficient resources to build at least a semi-structured technology management process. Hence, the selection of companies was based on relatively higher annual turnovers.

Field Work

Firstly, the selected companies were contacted and given information about the objectives and methodology of the study. Of the companies contacted only one refused to participate. Site visits lasting about half a day were arranged with the remaining 24 companies. The agenda of site visits consisted of a brief explanation of scope and objectives of the study, followed by information about the contents of the questionnaire and a plant tour. Then, the questionnaire was left to be filled in and sent back to the project team. Return of the questionnaires took about 20 days on the average and 21 questionnaires have been returned. Initial analysis of the results has provided the basis for the development of another questionnaire to be employed in the structured interviews to follow. Interviews have been conducted with the top management in 16 of the 21 companies.

Company Profiles

Of the companies surveyed, 52% are independent Turkish suppliers. These are the companies most challenged by the transformation in the industry and the recent developments in the Turkish automotive market. Thirty nine per cent are joint ventures with proportion of foreign participation ranging between 4% to 80%. The remaining 9% of the companies are wholly owned subsidiaries of multinational supplier companies. It is expected that foreign capital presence in the Turkish suppliers sector will gradually increase. Recent developments foster this process.

The sales of the companies surveyed range from 4m USD to 140m USD. The average is 41m USD. Between 1995 and 1997 the average annual sales growth is 7%. In the period examined the companies exhibited a moderate performance increasing their exports, on the average, by 5% annually.

Majority of the companies (66%) are small and medium enterprises. The average number of employees was 610 in 1997. Within the period from 1995 to 1997 the increase in the average number of workers was 10%. This means that the increase in the number of employees was higher than the sales increase which might indicate decreasing labor productivity.

BUSINESS STRATEGY AND TECHNOLOGY STRATEGY

Impact of Competitive Priorities on Technology Strategy

Business strategy constitutes the reference point for all company activities. Business strategy identifies the products and markets that will be exploited in the achievement of business objectives. It also defines the competitive advantages that will be pursued. Technology strategy identifies the contribution of technology to the competitive advantages pursued, and the means to increase that contribution. Different technologies offer different benefits with regard to productivity, quality, flexibility and timeliness. Importance attributed to different competitive priorities by the supplier firms is summarized in Table I.

Delivery dependability arises as the factor with the greatest importance for the suppliers. It is closely followed by aspects of quality such as conformance, reliability and durability. Delivery dependability and quality are areas where much progress has been realized in the last five to ten years. Recently these factors have turned into qualifying criteria. All technological choices should comply with the requirements of these criteria. On the other hand, design quality and brand image are not much emphasized. Some of the firms do not possess design capabilities anyway.

Product flexibility encompasses product innovativeness which is the ability to produce new or modified products cheaply and quickly, and customer responsiveness which refers to the ability to respond to customers' desires quickly regarding the characteristics of the product [10]. Product flexibility is emphasized by 75% of the companies. This reflects the effect of the accelerating pace of product innovation in the automotive industry. Product flexibility is especially important for suppliers that manufacture parts and components which might affect the perception of the consumer, because these components are redesigned for each new model. Along with organizational arrangements, product flexibility has clear technological implications.

[Insert Table I about here]

The ability to manufacture products quickly in different mixes and volumes, that is, process flexibility is of special significance for Turkish automotive suppliers. The diversity of customer base and limited sales volumes make flexibility a prerequisite for manufacturing technologies. They are forced to remain flexible while supplying parts at

decreasing prices and volumes. Increased flexibility seems to be a viable solution for this problem. On the other hand, flexibility has a cost, and this cost is an additional factor to overcome when competing on low prices. However, the cost incurred for achieving flexibility is very hard to measure and is usually overlooked. In another study performed in the supplier sector for the appliances industry, it has been observed that in order to secure flexibility requested by the manufacturers the suppliers increased their levels of raw material and finished goods inventory [11]. This indeed is a dilemma for the Turkish suppliers. An alternative strategy rarely discussed would be, reducing the need for flexibility by keeping a limited customer portfolio and product range.

The percentage of companies that strongly emphasize low price as a competitive priority is 15%. This is indeed expected since quality and delivery dependability are the qualifying factors when bidding for parts and components and price is usually determined by the manufacturer leaving little or no room for negotiation.

Some good practices for developing and executing technology strategy

Business strategy provides the basis for the development of functional strategies. These strategies must all support and contribute to the business strategy of the company in order for a firm to compete successfully. Intense competition and technological advances make technology an essential component of strategic management. Development of a technology strategy is the first step of the incorporation of technological aspect into the business strategy. It is identified that companies that succeeded in using technology for strategic advantage exhibit consistent and stable strategic management [12]. Among the Turkish suppliers that were surveyed, only 48% strongly emphasized that they have consistent and stable strategic management. The proportion of companies reporting that they have a systematic process for technology planning and strategy development is even lower, only 33%. This fact illustrates a major weakness. Having a systematic strategic planning process is found as having a significant impact on the company performance. The lack of a long term business strategy and of a formal strategic planning process is identified as a differentiating factor between successful and less successful companies [13,14]. Frohman [15] indicates that in the companies where technology is a high priority, the planning systems incorporate the technology plan as an integral part of the business plan. On the other hand, the development and use of formal technology planning and strategy development strongly relate to R&D performance [16]. Metz [7] states that for

successfully integrating technology planning with business planning one needs a structured process for technology planning, use of cross-functional teams, involvement of all functions in the technology planning process, and top management commitment.

One of the practices that are recommended for the alignment of business strategy and technology strategy is the participation of senior marketing and technology managers to strategic planning activities [16,17]. Additionally, in the formulation of technology strategy it is important to utilize customer feedback [16]. It was found that these good practices are not widespread among the Turkish supplier companies.

Having a chief technology officer near the top of the organizational ladder is another factor that facilitates the incorporation of technological issues into strategic decision-making. One study found that in Japan, 95% of the chief technology officers are members of boards of directors [16]. The representation of "voice of technology" at the top through direct face-to-face linkages is of critical importance. Of the Turkish supplier companies surveyed, 85% indicated that the highest position in charge of product and process technologies reports directly to the general manager. Furthermore, 55% of top level managers have an engineering background.

The successful management of technology requires a willingness to take a long-term view for technology accumulation within the company [18]. The development and diffusion of product and process technologies may require years. This fact makes long-term technology planning a prerequisite for a successful technology strategy. The companies that participated to the survey were asked to state the general planning horizon of their company. The average planning horizon is found to be 3.3 years. This is quite a short planning horizon. The major reason that inhibits long-term planning is the unstable macroeconomic environment in Turkey. Short planning horizon is a barrier especially for independent Turkish companies that strive to develop their own technological base.

TECHNOLOGY IDENTIFICATION

Technology identification is the first sub-process of the technology management process. Identification and evaluation of the technologies that may have a significant influence on the firm's current and future activities is the primary objective of technology intelligence activities.

Technology intelligence activities of the companies surveyed were evaluated in terms of formulation of information needs, selection of information sources, data collection, and evaluation, storage and communication of information. Since the effectiveness of technology intelligence activities is strongly dependent upon the underlying organizational structure, practices related to organization of technology intelligence activities among the surveyed companies was also a subject of interest in our study.

Formulation of Needs for Technology Monitoring

Among the companies that have been surveyed, 57% strongly emphasize that they monitor the developments in the field of their existing technologies and 52% strongly emphasize that they monitor technologies planned for future. The percentage of companies that monitor the technologies of competitors is substantially lower, at 29%. These findings reveal that about half of the companies either do not monitor technological developments in the relevant fields or do it in an ad hoc manner. However, informal information gathering may give a false sense of safety.

About half of the companies surveyed (52%) emphasize the availability of personnel in charge of technological monitoring. On the other hand, the use of consulting firms for technological monitoring is almost non-existent.

Selection of Information Sources

Table II ranks the various different sources of technological information used by the companies surveyed, in terms of relative frequency of usage and the relative benefit provided from the information obtained through that source type.

The most frequently used sources of information on technology includes trade fairs, customers, equipment suppliers, scientific and technical publications, affiliated companies, and product benchmarking. Sources such as equipment suppliers and customers (i.e. vehicle manufacturers) can provide information regarding new and emerging technologies in addition to existing technologies. Trade fairs and product benchmarking on the other hand, are sources of information about commercialized product and production technologies. Hence, information obtained from these sources will be of higher value to companies pursuing a technology follower strategy, such being the case for majority of the companies operating in the sector in Turkey.

Disclosed patents seem to be the least frequently used source of information. With to the recent availability of world wide patent search facilities over the Internet such as the European Patent Organization's new *esp@cenet* patent search facility (available at *http://ep.dips.org*), we may expect the industry to resort this valuable information source more frequently in the future.

As to the relative benefit derived from information obtained through different types of sources, product benchmarking is rated highest among those companies that practice it, followed by information obtained from customers and equipment suppliers. It is notable that, reverse engineering, a practice that does not seem to be widely popular within the sector is found to provide beneficial information by those companies who practice it.

[Insert Table II about here]

Evaluation, Storage and Communication of Information

Of the companies participating in the survey, 38% strongly emphasized that they evaluate the impact of new and emerging technologies on the sector and on their company. The percentage of companies that evaluate the commercial potential of new and emerging technologies is 43%. These results indicate the high vulnerability of the remaining companies against new and emerging technologies.

Fourteen per cent of the companies participating in the survey indicated that they have procedures that define the information analysis process. Compiled information is put into a report format and sent to relevant personnel in 48% of the companies. The proportion of companies that use computer systems for storage of gathered information was found to be a rather low figure of 24%.

Technology Intelligence Organization

The organizational arrangements aiming systematic technology intelligence are not widespread among the surveyed companies (Table III). This somewhat unstructured and ad hoc approach to technology identification is expected to have a negative impact on the overall technology management process in these companies. In fact, 57% of the companies surveyed indicated the absence of or deficiency in their technology intelligence organization as a major obstacle to successful technology selection.

[Insert Table III about here]

TECHNOLOGY SELECTION

Technology selection involves selection among technological alternatives identified through technology identification process. It is a multifaceted and complex process. Technology selection becomes especially complex in the choice of technologies requiring large and long-term investments. Economic analysis also plays an important role in technology selection.

The principal factors of technology selection are business and technology strategy, company infrastructure and environmental factors.

The effect of business and technology strategy

Business strategy should be the starting point of all company activities. All major decisions should comply with the business strategy and serve to the business objectives set.

Undefined technology strategy is a barrier to successful technology selection because it establishes the connection between technology choice and business strategy. Technologies selected by a company need to be consistent with its technology strategy. Furthermore, the alignment of business strategy and technology strategy is a major research area. Business strategy affects the strength of the relation between company performance and particular technology strategies [19,20].

[Insert Table IV about here]

The assessment of the barriers to successful technology selection gives clear insights (Table IV). Undefined business strategy and short planning horizon are considered by 75% of the companies as a barrier or a great barrier. The respective proportion for undefined technology strategy is 65%.

The companies studied also face difficulties in the process of alignment of business and technology strategies. Sixty five percent of them view it as a barrier or a great barrier to successful technology selection.

The effect of product and market characteristics

The choice of process technology depends on the characteristics of the product and its market [21]. The impact of following factors is evaluated.

Lot Sizes and Product Line Breadth. Lot sizes significantly influence the choice of process technologies. Lot sizes determine the level of flexibility that is required from the manufacturing system. Majority of the participating companies (60%) emphasize the great impact of lot sizes on their technology choices. Of these companies, 60% describe the reason as the need to produce in small lots. Product line breadth is another factor that influences the choice among technological alternatives. Broad product line increases the need for flexible manufacturing operations. It also increases the administrative costs. The companies participating to the survey are aware of the significant impact that product line breadth has on their choices of manufacturing technology. The proportion of companies that indicate great impact is 65%. Furthermore, the major reason for this impact is the wide product line they carry.

Customer Relationships and Product Innovation Rate. The stability and duration of company-customer relationships are key elements that determine the choice of manufacturing technology [22]. This finding is also confirmed by the results of the survey among Turkish automotive suppliers. Eighty five percent of the companies indicates that customer relationships have great impact on their technology choices. In most companies (70%), customer demands influence the selection process. Long-term agreements with customers are another factor that affects the decision of a number of companies (20%).

Market Characteristics. The demand for automotive products is highly elastic in Turkey. Political and macroeconomic developments directly affect the demand. Sixty five per cent of the companies indicate that demand stability plays a major role in their decisions regarding technology. Unstable demand arises as a major inhibitor for all company activities including technology selection.

Market growth is another important factor affecting selection. Some sub-sectors experience stagnating or shrinking market. The proportion of companies indicating this kind of unfavorable market condition is 56%. Political and economic conditions influence particularly the companies that supply domestic vehicle manufacturers. Instability in these conditions leads to considerable fluctuations in demand. These findings are confirmed by the opinions expressed regarding market related barriers to successful technology selection. Political instability is a major cause of the fluctuations in the demand for motor vehicles in Turkey. These factors are strongly emphasized as constituting a barrier to

successful technology choice decisions. Inadequate market information and poor analysis of market conditions are not conceived as significant barriers.

The effect of company resources

A company's resources define the strategy it can pursue [23]. Therefore, capital and human resources are expected to impact technology selection decisions.

[InsertTable V about here]

The effect of company resources on technology selection decisions is summarized in Table V. Financing requirements are identified as having great impact by 55% of the companies. Taking into account the high interest rates of financing, this percentage is not very high. The reason for this may be that companies do not refer to external financing and try to meet investment expenditures from internal sources.

The level of workers' capabilities and the level of management capabilities do not appear to have a significant impact on the selection among technological alternatives. On the other hand, engineering capabilities are more emphasized as a factor affecting technology selection decisions. This fact also makes clear the need for continuously upgrading the engineering skills through training.

Company culture is a factor with highly emphasized influence on technology choice. One of the elements of company culture is the attitude of management towards technology. In some cases that attitude becomes the deciding factor in technology selection. The impact of quality infrastructure is moderate. A strong quality infrastructure may support more advanced technologies.

Role of economic analysis in technology selection

The use of economic analysis methods is found to be not widespread among the surveyed companies. The most frequently used method is pay back period analysis. Considering that Turkey suffers from a chronic high inflation rate, this choice appears to be reasonable. It is followed by net present value analysis and internal rate of return analysis. Approximately one third of the companies reported that they never use any of these techniques.

Of the qualitative factors that need to be included in the evaluation of the technological alternatives, the increase in quality is the most emphasized. This is an expected result

since quality is one of the dominating competitive priorities and quality improvement is the principal objectives of many technological investments. Customer satisfaction is the second most frequently evaluated factor in the selection of technologies. This is partly a result of the explicit technological demands of customers.

The low utilization of the economic analysis methods can be explained by fact that strategic considerations dominate such decisions. The proportion of companies that emphasize strategic issues in the selection of technologies requiring large investment is 50%. In the unstable macro-economic environment in Turkey, accurate identification of economic benefits of a given technology investment is even more difficult. Therefore, strategic analysis is more appropriate for this type of technology selection decisions.

TECHNOLOGY ACQUISITION

The balance between internal technology development and external acquisition, the emphasis on R&D activities, and relative technological standing are principal ingredients of technology strategy. In general, within a company the two major sources of technology are R&D/Engineering and the production unit. Mostly, R&D organization concentrates on product technologies, while production technologies are the primary responsibility of the production unit. On the other hand, since no company can develop all the technologies it uses, external technology acquisition is also as important. There could be diverse sources for external acquisition of technology.

Internal Sources for Technology Acquisition

The companies in the sector mostly acquire technologies by internal development or purchase of technology embedded in products, materials, equipment, and processes. Although R&D/Engineering is utilized at a slightly lower rate (86%, compared to 90% Production use), it is deemed very efficient by the majority (63%, compared to 42% of production). The principal reason for internal development is the willingness to gain expertise in a particular technology (Table VI).

[Insert Table VI about here]

Despite the fact that internal development is practiced by 62% of the companies R&D expenditures are quite low. In 1997, 64% of the companies reported R&D expenditures lower that 0.5 per cent of that year's sales. Only 12% of the companies reported R&D

expenditures greater than 1%. The change over the past three years is negligible. The average annual increase is 3%. Table VII depicts percentages of R&D expenditures and equipment purchase costs to total sales for the surveyed companies in three groups. In the first group there are companies with number of employees less than 250, the second group contains companies with 251 and 500 employees and group three contains companies with more than 500 employees. In each group there are seven companies.

[Insert Table VII about here]

For all the years covered there is an increasing trend of equipment purchase percentages from Group I through Group III. The R&D expenditures percentage is distinctively higher for Group III companies. Group I has a larger percentage compared to Group II. A possible reason for this could be that Group I needs to develop more endogenously since they do not have enough resources to purchase equipment comparable to Group II. The comparison of R&D expenditures with external equipment and technology acquisition expenditures reveals a great dependence on external technology.

External Sources for Technology Acquisition

While trade fairs and conferences stand out as the major technology source, university laboratories and R&D institutions are distinctively not utilized (Table VIII).

[Insert Table VIII about here]

Lack of skills, over occupation of R&D function with incremental improvements, and the need to reduce the uncertainties in the performance of new technology, are the factors leading to acquisition of externally developed technologies.

TECHNOLOGY EXPLOITATION, PROTECTION, AND ABANDONEMENT

Exploitation

One might consider four major ways of technology exploitation: employing in its own processes or products; contracted-out manufacture or marketing; joint-venture; and license-out. A company's relative self-confidence and competence in the technology development process influence the exploitation decisions. With lower competence and confidence, the external exploitation of technology decreases.

The study shows that, to a great extent, Turkish companies exploit the technologies available in their stock internally and although many companies have developed their own technological competencies, they lack experience in the external exploitation of these.

It appears that the greatest impact of new technology on operational results comes from production technologies and mostly as reduction in the production cycle time and as increase in the manufacturing capacity and flexibility (Table IX).

[Insert Table IX about here]

Protection

The technology can diffuse very fast and in so many different ways that one needs to slow down this process not to loose competitive edge in the market.

The study shows that companies in the sector do not utilize legal protection methods such as patenting and design registration. Furthermore, other protection mechanisms such as confidentiality assurance, lead time advantage due to early introduction, and keeping the related personnel in the company are considered as "moderately efficient".

Lack of distinctive technological competencies and proprietary technologies appears to be the reason for not utilizing legal protection methods. With the creation of proprietary technologies the emphasis on protection methods will inevitably increase.

Abandonment

The stimulus for phasing out a technology can be classified into two groups: technology push–the emergence of new and better technologies, and market pull–market demand for new technological solutions. Market pull and technology push are interdependent. Market demand triggers new technological endeavors, while technological innovations raise new demands.

The findings are: the cases of technology abandonment are not widespread. The small number of cases reveals the explicit demands of customers and the decrease in the demand of particular products as the two major market-driven factors for phasing-out. Among the technology driven factors for abandonment, the shift to technologies providing cost advantage is the principal one. Legal and contractual requirements impact the abandonment of product technologies. Inability to identify technological alternatives is the most emphasized barrier to successful technology abandonment.

Table X lists major factors for the abandonment of product technologies due to market pull. Two outstanding factors are decrease in the demand for products containing the technology and explicit demands of institutional customers to shift to new technologies.

[Insert Table X about here]

Shift to technologies providing cost advantage is the prevalent reason for phasing-out of product technologies (Table XI). Cost reduction is the focal point of new product technologies in the automotive industry. This factor is identified as very important in the abandonment decisions of two thirds of the companies. Technologies providing advantages in quality and flexibility (both in new product development and in production) are also favored as reasons to abandon a current product technology.

[Insert Table XI about here]

SOME MANAGERIAL IMPLICATIONS

Management Practices. The level and nature of the interaction between the vehicle manufacturers and their suppliers in Turkey leaves a large room for improvement. In a study conducted in 1997 among the vehicle manufacturers in Turkey, supplier relationship was cited as the practice contributing the least to the success of the company [24]. Practices like strategic alliances and early supplier involvement are rarely employed. Both parties need to work harder to establish mutual trust. Networks built on trust are also needed among the suppliers themselves in order to respond to the challenge of becoming system suppliers.

Technology strategy. A crucial observation is related to strategic planning. It appears that a formal, systematic strategic planning is lacking. In general, planning horizon is relatively short. All these result in a lack of technology strategy. In those companies where business strategy and technology strategy can be claimed to exist, an alignment of these strategies is missing. The volatile nature of the market is cited as an excuse for this deficiency.

Core technical competences. Most of the supplier companies investigated are not able to define their core technical competences. Some of them are not aware of their core technical competences. The areas where such competences already exist and where the development of specific competences is desired should be explicitly specified. Resources

should be provided by the management to promote such areas and particularly to develop skills necessary in the company.

The need for flexibility. Flexibility appears to be an essential competitive priority for parts and components suppliers in Turkey. The supplier companies emphasize flexibility as a major advantage in competing with their competitors abroad. The supplier companies need to be flexible due to two main reasons. First, the orders received from vehicle manufacturers in Turkey are for relatively small quantities. Thus the supplier companies opt for product proliferation in order to increase their total volume and to reach a certain scale. The second reason is that the production plans of the vehicle manufacturers in Turkey change frequently and abruptly. Although the vehicle manufacturers apply frozen demand and frozen schedule approach to their suppliers abroad, they don't do so to their local suppliers. Thus the supplier companies need to be flexible in order to survive in such an environment.

Technology monitoring. A general observation has been the lack of skills and organization for technology monitoring. There are certain activities but they are performed in a rather loose fashion. A more formal approach is needed. Formally defining technology monitoring as a function gives the message to the employees that the management puts emphasis on this issue. It does not need to be organized as a separate department but can be assigned to a particular person or a group of persons with the precaution that it should be part of their job description.

Technology selection. There is a need for selecting technology in alignment with business strategy. The technologies selected should serve the competitive priorities of the company. This, of course, is closely related to the existence of an explicitly stated technology strategy.

Technology acquisition. R&D activities cover the development of product and production technologies and the new product development. There has been considerable emphasis on the development of production technologies leading to improvements in manufacturing costs and product quality. Product technologies and new product development are neglected mostly due to the environment in which the supplier companies operate. The vehicle manufacturers in Turkey operate mostly under licences from vehicle manufacturers abroad and do not have major design activities themselves. Thus they cannot create an atmosphere conducive for product innovation. Interestingly, the suppliers

in Turkey have co-design experiences mostly with vehicle manufacturers operating abroad. The companies need to put more resources into R&D activities to improve their level of technology and core competencies to improve their competitiveness in an industry where more of the design responsibilities are transferred to the suppliers and where system suppliers are promoted.

CONCLUSIONS

The automotive suppliers in Turkey face a stiff competition. The global competition forces them to take innovative measures to secure long term survival. They are at a crossroad. Either they will grow by simultaneously increasing their scale of operations and the added value component in their sales or they will perish. Relative to global scale the automotive suppliers in Turkey are small supplier companies and with their current positioning they are constrained to a great extent by the policies of the manufacturers in Turkey which are small scale operations themselves. The added value component is decreasing for the suppliers over the years. Many of these companies cannot meet the price reductions through productivity increases but simply have to accept reduced profits. First tier companies become second tier companies; second tier ones third tier. It is becoming widely accepted that an export oriented marketing policy is the only way out of this situation. Those trying to develop strategies and policies to secure long term survivability soon realize the need for a technology strategy and a sound technology management process.

Mainly because of the situation briefly described above, the study has provoked great interest among the supplier companies in the sample. The investigation of the current technology management practices has been well accepted by the companies. The questionnaire has proven itself to be a useful tool applicable in practice. Some companies have conceived it as a tool for technology audit and some as a starting point for building and developing their own technology strategies.

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REFERENCES

1. Ulusoy G., Payzın, E., Bilgiç,T., Kaylan, A.R. and Özgür, A. (1998) *Technology and New Product Development Management in the Automotive Parts and Components Suppliers Industry in Turkey*, TÜSİAD Publications, İstanbul (in Turkish).
2. http://www.osd.org.tr/dunya.htm.
3. *Power Journal* (1998) (9): September, İstanbul. (in Turkish).
4. Ealey L., and Bermudez, L.T. (1996) Are the automobiles the next commodity?, *The McKinsey Quarterly,* (4): 63-75.
5. Too many pieces (1998) *The Economist,* **347** (8067): 90-91.
6. Mullineux, N. (1998) *The Automotive Components Industry*, Pearson Professional Ltd., London.
7. Metz, P.D. (1996) Integrating technology planning with business planning, *Research Technology Management*, **39** (3): 19-22.
8. Probert, D. and Gregory, M. (1995) A process model for the management of technology: mapping techniques and sectoral characteristics", *Proceedings of the International Association for Management of Technology Conference*, Aston, 431-438.
9. Pandya, K.V., Karlsson, A., Sega, S. and Carrie, A. (1997) Towards the manufacturing enterprise of the future, *International Journal of Operation & Production Management*, **17** (5): 502-521.
10. Kleindorfer, P.R. and Partovi, F.V. (1990) Integrating manufacturing strategy and technology choice, *European Journal of Operational Research,* **47** (2): 214-224.
11. Ulusoy, G., Toker, A., Karabatı, S, Barbarosoğlu, G., İkiz, İ. (1999) *Competitiveness Strategies and Business Excellence in Parts and Components Suppliers to the Appliances Industry*, TÜSİAD, İstanbul (in Turkish).
12. Morone, J. (1989) Strategic use of technology, *California Management Review*, **31** (4): 91-110.
13. Shrader, C.B., Taylor, L. and Dalton, D.R. (1984) Strategic planning and organizational performance: a critical appraisal, *Journal of Management*, **10** (2): 149-179.

14. Pearce, J.A., E.A. Freeman , and R.B. Robinson, Jr. (1987) The tenuous link between formal strategic planning and financial performance," *Academy of Management Review,* **12** (4): 658-675.

15. Frohman, A.L. (1985) Putting technology into strategic planning, *California Management Review*, **27** (2): 48-59.

16. Roberts, E. (1995) Seeking global technological advantage, *IEEE Engineering Management Review*, **23** (3): 4-13.

17. Frohman, A.L. (1982) Technology as a competitive weapon, *Harvard Business Review*, **60** (1): 97-104.

18. Pavitt, K. (1990) What we know about the strategic management of technology?, *California Management Review*, **52** (3): 17-26.

19. Zahra, S.A. and Couin, J.G. (1993) Business strategy, technology policy and firm performance, *Strategic Management Journal*, **14** (6): 451-478, 1993.

20. Schoeder, D.M., Congolen, S.W. and Gopinath,C. (1995) Linking competitive strategy and manufacturing process technology, *Journal of Management Studies*, **32** (2):163-189.

21. Grant, R.M., Krishnan,R., Shani, A.B. and Bae, R.(1991) "Appropriate Manufacturing Technology: A Strategic Approach," *Sloan Management Review*, **33** (1): 43-54.

22. Williams, J.R., and Novak, R.S. (1990) Aligning CIM strategy to different markets, *Long Range Planning*, **23** (1): 126-135.

23. Grant, R.M. (1991) The resource-based theory of competitive advantage: implications for strategy formulation," *California Management Review,* **33** (3): 114-135.

24. Ulusoy G., Özgür, A. (1997) *Competitiveness Strategies and Business Excellence : Vehicle Manufacturers in Turkey*, TÜSİAD Publications, İstanbul (in Turkish).

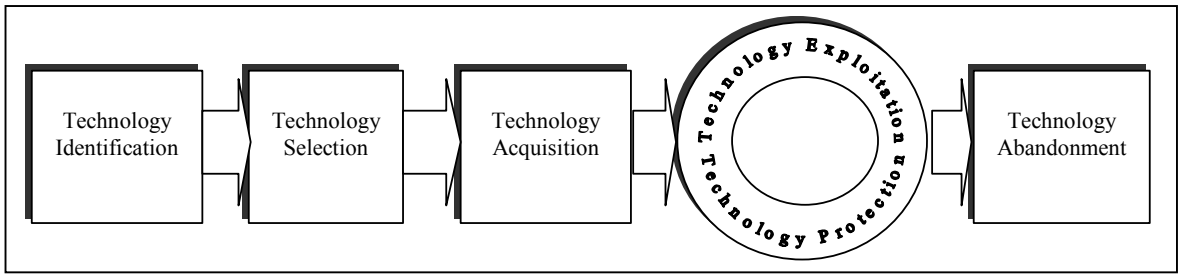

Figure 1. Technology Management Process Model

Table I. Importance of competitive priorities (%)*

Competitive Priorities	*Low*	*Medium*	*High*
Product quality			
Design quality	5	45	50
Conformance to specifications	0	14	86
Durability	10	19	71
Reliability	5	14	81
Image / brand	14	24	62
Delivery Dependability			
Ability to deliver at the required place	0	25	75
Ability to deliver at the required time	0	14	86
Ability to deliver at the required quantity	0	10	90
Flexibility			
Product flexibility	0	25	75
Process flexibility	10	29	62
Customer services	5	35	60
Low price	10	75	15

*Answers to the question "Please indicate the importance devoted to the cited factors."

Table II. Sources of information used for technology intelligence (%)

Information Source	*Frequency*			*Contribution*		
	Never	*Sometimes*	*Often*	*Little*	*Moderate*	*Great*
Customers	10	43	48	16	26	58
Equipment suppliers	0	57	43	10	43	48
Trade fairs	5	52	43	15	40	45
Related companies	14	43	43	22	28	50
Scientific and technical publications	14	48	38	22	50	28
Product benchmarking	29	33	38	0	40	60
Material suppliers	14	62	24	6	67	28
Dealers	38	38	24	23	38	38
Scientific and professional meetings	10	71	19	26	47	26
Reverse engineering	57	29	14	11	56	33
Chambers of commerce / industry	52	38	10	56	33	11
Companies from other sectors	48	48	5	18	73	9
Universities	48	48	5	36	55	9
Professional associations	67	29	5	14	71	14
Consulting companies	52	48	0	11	67	22
Disclosed patents	75	25	0	20	60	20

Table III. Practices related to technology intelligence organization (%)

Practice	*Do not agree*	*Partly agree*	*Strongly agree*
Important information is periodically reviewed and if necessary follow up activities are initiated.	19	57	24
Technology intelligence function is explicitly defined and included in the job description of the related personnel	43	33	24
The services provided by the technology intelligence function are known by the other functions	43	33	24
Technology intelligence function has clearly defined objectives	57	29	14
Technology intelligence activities are budgeted	57	33	10
The performance of technology intelligence function is regularly revised	57	38	5

Table IV. Barriers to successful technology selection

Factor	*Does not constitute a barrier*	*Constitutes a barrier*	*Constitutes a great barrier*
Short planning horizon	25	55	20
Undefined business strategy	25	65	10
Undefined technology strategy	35	50	15
Poor alignment of business and technology strategy	35	55	10

Table V. The effect of company resources

Factor	*No Impact*	*Little Impact*	*Great Impact*
Financing requirements	10	35	55
Cash flow	15	40	45
The level of workers' capabilities	40	45	15
The level of engineering capabilities	35	20	45
The level of management capabilities	30	50	20
The level of quality infrastructure	35	25	40
Company culture	25	20	55

Table VI. Reasons for acquiring technology from internal sources (%)

Reason	*No impact*	*Little impact*	*Great impact*
The company wishes to gain expertise in a particular technology	0	18	82
R&D area is close to existing technical capabilities	6	35	59
Internal R&D is less expensive than acquisition from external sources	18	35	47
The company wishes to keep its technological thrust confidential	18	35	47
The company culture fosters the belief that the only good technology is developed internally	59	41	0

Table VII. Percentages of R&D expenditures (*Equipment purchase costs*) to total sales

Group	*1995*	*1996*	*1997*
Group I	0.5 (*1.3*)	0.5 (*2.1*)	0.3 (*3.9*)
Group II	0.1 (*6.8*)	0.1 (*9.1*)	0.3 (*9.3*)
Group III	1,3 (*9.3*)	1.2 (*11.0*)	1.0 (*10.9*)
Total	**0.7 (*6.1*)**	**0.6 (*7.7*)**	**0.5 (*8.3*)**

Table VIII. Use and efficiency of external technology sources

Source	*Per cent of usage*	*Efficiency (per cent)*		
		Not efficient	*Moderately efficient*	*Very efficient*
Trade fairs, conferences	95	16	47	37
Publications	86	6	76	18
Customer companies	80	0	63	38
Related companies	76	0	44	56
Supplier companies	70	14	57	29
Consulting companies	45	11	89	0
Other companies	38	13	75	13
University laboratories	14	0	100	0
R&D institutions	10	0	50	50

Table IX. Results of new technology use - quantitative (%)

Operational result	*No change*	*Moderate improvement*	*Major improvement*
Increase in conformance quality	0	35	65
Reduction in production lead time	10	30	60
Increase in manufacturing capacity	0	48	52
Increase in production precision	15	40	45
Decrease in the time for new product development	20	40	40
Cost reduction	10	52	38
Increase in flexibility	20	45	35
Decrease in setup times	10	57	33
Increase in safety	15	60	25
Decrease in lot sizes	45	35	20

Table X. Abandonment of product technologies - market pull

Factor	*Constitutes a reason (per cent)*	*Importance (per cent)*		
		Less important	Important	Very important
Decrease in the demand for products containing the technology	86	0	33	67
Explicit demands of institutional customers to shift to new technologies	71	0	40	60
Shift of competitors to new technologies	43	0	100	0
Abandonment of existing technologies due to becoming:				
Inadequate in regard to technical specifications	63	0	40	60
Cost disadvantageous	63	0	80	20
Inadequate in regard to environmental regulations	33	100	0	0
Inadequate in regard to occupational safety	25	0	50	50
Inadequate in regard to consumer safety	14	0	0	100

Table XI. Abandonment of current product technologies - technology push

Factor	*Constitutes a reason (per cent)*	*Importance (per cent)*		
		Less important	*Important*	*Very important*
Shift to technologies providing cost advantage	75	0	33	67
Shift to technologies providing advantages in various aspects of quality	57	0	50	50
Shift to technologies providing flexibility in new product development	57	0	75	25
Shift to technologies providing flexibility in manufacturing	57	0	75	25