TECHNOLOGY PROCESSES MANAGEMENT CAPABILITY PROFILES OF FIRMS IN AUTOMOTIVE, WHITE GOODS AND ELECTRONICS SECTORS IN TURKEY

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ABSTRACT

Technology management becomes an important criterion for the firms in order to be successful in competitive environment. The economic strength of the countries depends on their ability to create their own technology and turn it into economic and social benefit. This paper aims to assess technology management capabilities and draw capability profiles of firms in automotive, white goods and electronics industries in Turkey. Using a capability assessment process model, this study diagnoses the actual source of deficiency in management of technology processes and makes recommendations for enhancement of the technology-related practices.

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1. INTRODUCTION

All aspects of life and economy are increasingly influenced by the technological change. Technology and coping with technological change have become prime factors for the competitiveness of companies and also of countries.

Technology refers as the theoretical and practical knowledge, skills and methodology that can be used to develop products and services as well as their production and delivery systems. Technology can be embodied in materials, cognitive and physical processes, people plant equipment and tools. Werther, Berman, and Vasconcellos [11] argues that, technology management, however has a broader charter: the integration of technology throughout the organization as a source of sustainable competitive advantage.

Tschirky [10] suggests that, the discipline of technology management represents a substantial extension of the original industrial sciences. In its essence technology management closes a gap within general management theory and practice by relating technological knowledge directly to management concepts.

The effective application of technology is a key source of competitive advantage for modern industry. However, the integration of technology management systems into established business processes represents a continuing challenge to many firms. This paper describes the use of a model for the assessment of technology management practices. Based on process model of technology management, the research provides a means whereby manufacturing companies can assess the effectiveness of the technology management activities critical to their business, and identify areas for improvement or transfer of good practice. If the firms have sufficient capabilities for integrated technology management with their business strategy, they can use technology effectively.

Business strategies are formulated to determine the way in which organizations can move from their current competitive position to a new stronger one. This can only be achieved by improving an organizations competitiveness. A universal and exact definition for competitiveness does not exist. As a result, competitiveness means different things to different organizations. Some organizations view competitiveness as the ability to persuade customers to choose their offerings over alternatives while others view competitiveness as the ability to improve continuously process capabilities.

In the management and economic literature, it is widely accepted that technology is a source of competitive advantage. Abernathy and Clark [1] state that *"technological innovation has been a powerful force for industrial development, productivity growth and indeed, our rising standard of living throughout history"*. Porter [7] sees technology as *"perhaps the single most important source of major market share changes among competitors and probably most frequent cause of the demise of entrenched dominant firms"*. According to Frohman [3], technological change can either create or destroy, profits, markets and industries. In short, it is a *"vital force in the competitive environment of the modern firm"* [5].

As companies respond to global competition, there is a growing recognition of pivotal role of technology in determining market success. As a result of this recognition, companies have increased their adoption of advanced technologies and, also, their introduction of technologically sophisticated products. These changing practices have

altered companies to the need for developing technology policies that are consistent with or fit business strategy. This fit ensures the successful deployment of a company's technological capabilities and resources in persuit of the goals of business strategy. Such effective deployment of technological resources helps to built a sustainable comptitive advantage that enhances a company's financial performance [14].

Business strategy defines a long-term plan of action a company may pursue to achieve its goals. Technology policy embodies the choices companies make about acquiring, developing and deploying technology to help reach the goals of their business strategy [2]. The literature stresses the need for fit between business strategy and technology policy. According to Porter [7], this fit means that the choices in business strategy and technology will be compatible, thus reinforcing one and other.

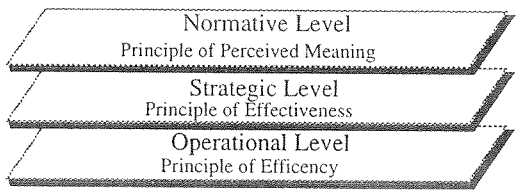
Probert et al. [8] state that, technology management, as a subject area, combines elements of engineering, science and management, and is consequently truly multidisciplinary. Similarly, consideration of these issues in a manufacturing business requires the skills and knowledge of people from many functions and departments. Tarr [9] argues that, beyond the innovative process in R&D, the management of technology includes the controlled introduction and use technology in products, manufacturing processes, and internal organizational functions. A key focus is the integration of technology in to overall business operations instead of isolating the technology within special-purpose functions.

2. METHODOLOGY

The model used in this paper *Technology Processes Management Capability Profiles Model (TPMCPM)* provides a framework for linking technology with business needs. The capability indices revealed by application of TPMCPM on the firms help diagnosing and identifying the actual reasons for deficiency in management of technology processes, areas of strength and weakness. TPMCPM is applied in order to assess the technology management capabilities of the automotive, white goods and electronics firms. TPMCPM is based on the research and model that was proposed by Gregory [4] and later enhanced by Probert et al. [8]. Their model suggests that there are five basic processes to be considered in managing technology management within a manufacturing business: *identification, selection, acquisition exploitation and protection.* Özgür [6] and Yüksel [13] added the sixth sub-process of *abandonment.*

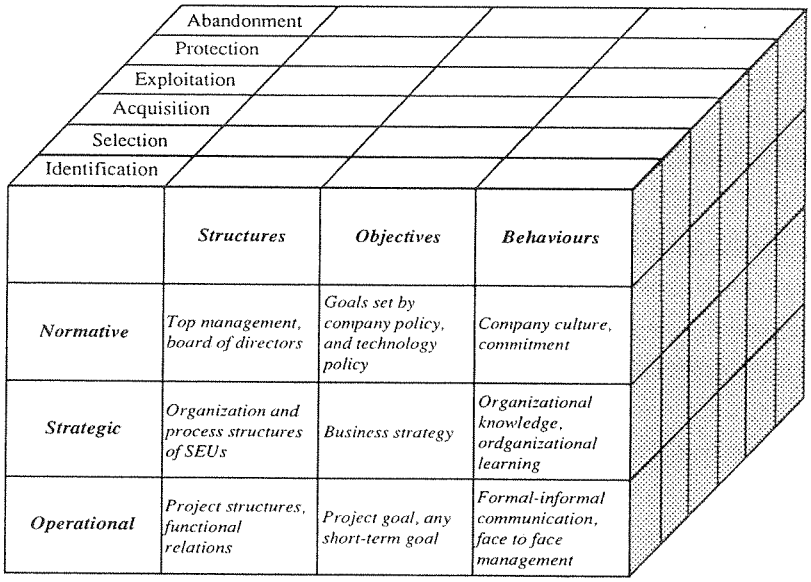
According to Tschirky [10], technology management's role is to close the gap within general management theory and practice by relating technological knowledge directly to management concepts. He makes three-part differentiation between management tasks. He groups the *strategic* and *operational* levels under a higher *normative* level of management (Figure 1).

FIGURE 1: THREE LEVELS OF MANAGEMENT [10]



TPMCPM [12] integrates technology management processes with the technology management levels. In each sub-process, there are activities included in a management level and classified as *structure, objective* or *behaviour* (Figure 2).

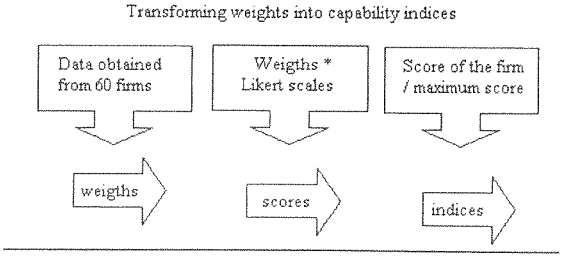
FIGURE 2: FRAMEWORK OF TPMCPM



	Structures	*Objectives*	*Behaviours*
Normative	*Top management, board of directors*	*Goals set by company policy, and technology policy*	*Company culture, commitment*
Strategic	*Organization and process structures of SEUs*	*Business strategy*	*Organizational knowledge, ordganizational learning*
Operational	*Project structures, functional relations*	*Project goal, any short-term goal*	*Formal-informal communication, face to face management*

The questionnaire is used as a survey instrument. It was used before by Özgür [6] and Yüksel [13], then improved by Yıldırım [12]. The questionnaire consists of twelve sections. Section 1 focused on the general information of the firms. Section 2 focused on issues relating to engineering capabilities of the firms. Section 3 through 8 focused on 6 sub processes of technology management practisces according to process model. Section 9 as aimed to assess the new product manufacturing practices while section 10 as aimed to assess the new product development activities of the firms. Section 11 gathered information about the results of new technology usage while section 12 as aimed to get information about barriers to success of technology management practices. Most answers were reported on a five point likert scale indicating(1):do not agree or not important, (5): strongly agree or very important.

FIGURE 3: BASIC STEPS OF CALCULATING INDICES [12]



Yıldırım [12] applied the questionnaire to 200 firms representing different industries in order to learn how firms weigh the importance of each sub-processes considering their contribution to the overall success of their firms. 60 firms out of 200 returned their importance scorings. Thus, the weigths obtained from 60 firms lead us to scores by multiplying the weights by likert scales that the company selected in the questionnaire. The scores lead us to the capability indices by dividing score of the company to maximum score (Figure 3).

Application of the process model to the firms reveals three sets of management capability indices:

1. Management level capability indices (normative, strategic, operational).
2. Activity management capability indices (structures, objectives, behaviours).
3. Technology management sub-processes capability indices (identification, selection, acquisition, exploitation, protection, abandonment).

Normative index denotes the capability in making primary decisions according to the long-term goals of the company. Existence of a consistent company policy and the culture developed in the company are the major factors that affect the normative index.

Strategic index denotes the capability of the company in transposing its company policy into comprehensible strategies. Especially the management of sub-processes affect the strategic index. *Operational index* denotes the capability of the firms in transforming strategies into practice in the context of short term goals. Capability of the firms in carrying out company projects and allocating proper resources according to the plan shapes the level of operational index. The higher the operational index, the more efficient the company.

Structure index denotes the capability of the firms in constructing their structures of all kinds in the company. Structure of top management body in the firms, organizational structures and operational structures affect the level of structure index. High structure index exhibits the strength of all structural arrangements in the company. *Objective index* denotes the capability of the firms in formulating their company policy, technology policy, business strategy, and project goals. It shows the strength of company in formulating long-term, middle term, and short term goals. *Behaviour index* denotes the strength of company culture, organizational and individual learning practices and opportunities, management behaviours, communication principles, etc., in the company.

The existence of high *technology processes management capabilities* within a firm implies that the firm has sufficient capabilities for integrating technology management with its business strategy and the firm views technology management as an integrated component of its general management.

3. RESULTS AND DISCUSSION

Analyzing the Firms

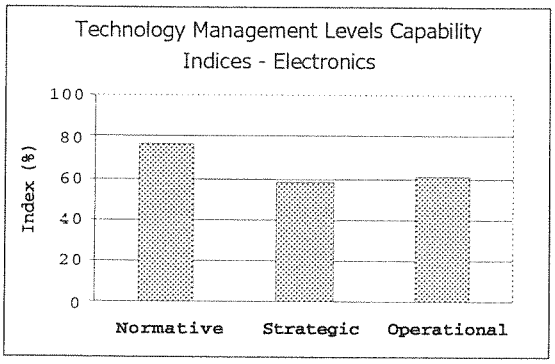
Each of the participant 6 firms from automotive, white goods and electronics sectors gets the capability indices upon the scoring process. In addition to 6 firms, another 9 firms from machine manufacturing sector [12] are included in the analysis in order to increase the sample size in the SPSS factor analysis (Table 1).

TABLE 1: CAPABILITY INDICES OF ALL FIRMS

	Management Capability Indices											
FIRM NO	Normative index	Strategic index	Operational index	Structure index	Objective index	Behaviour index	Identification index	Selection index	Acquisition index	Exploitation index	Protection index	Abondonment index
Firm A	81	64	83	92	76	70	86	91	59	57	58	4
Firm B	84	56	58	87	99	30	67	66	58	51	59	34
Firm C	75	63	66	67	73	55	60	65	68	52	36	22
Firm D	78	52	73	31	75	63	63	58	65	51	36	35
Firm E	84	64	72	73	74	65	77	75	71	65	86	0
Firm F	10	47	70	64	65	53	49	0	60	35	72	93
Firm 1	90	57	52	60	29	72	82	84	61	59	50	0
Firm 2	89	51	41	46	50	56	31	84	48	48	35	77
Firm 3	57	18	38	39	17	28	47	0	0	27	0	0
Firm 4	88	34	49	48	23	51	48	49	58	36	42	0
Firm 5	73	52	43	49	43	57	65	95	64	53	54	0
Firm 6	95	54	47	58	26	69	61	95	9	43	48	0
Firm 7	80	48	30	46	20	57	80	94	66	58	94	0
Firm 8	88	65	70	66	35	85	37	81	42	70	64	0
Firm 9	94	48	67	54	24	75	49	76	45	43	30	22

Considering these indices, the firms were examined. As a result of the examination, each of the 6 firms belonging to one of the 3 sectors gave some idea on the current situation of these sectors. Additional 9 firms were examined in the same way by Yıldırım [12]. The means of management capability indices of the participant firms reveal the deficiencies in each of the 3 sectors (Figure 4 through 9):

FIGURE 4: MEAN OF MANAGEMENT LEVELS AND ACTIVITY CAPABILITY INDICES OF ELECTRONICS SECTOR



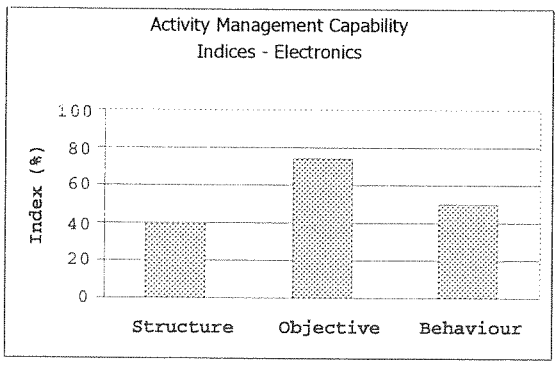
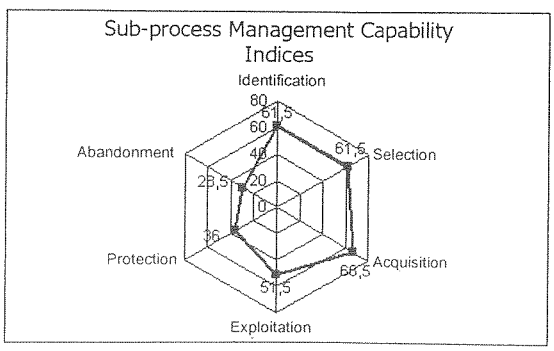
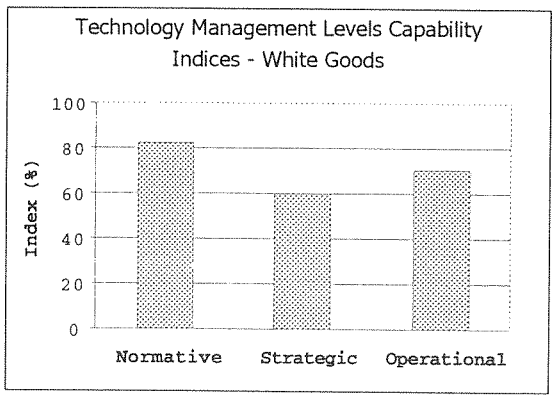


FIGURE 5: MEAN OF SUB-PROCESS MANAGEMENT CAPABILITY INDICES OF ELECTRONICS SECTOR



Electronics sector has a relatively high capability in normative level in which it makes its primary decisions according to long term goals of the company. Although it experiences the same problem of forming strategic consideration according to normative issues, the sector is among the most powerful sectors in operational strength category. Putting more emphasize on defining strategic goals and middle term targets emerges as one of the major needs for this sector. High objective shows to be the strength in formulating long term goals. Exploitation, protection and abandonment stages of technology management should be reviewed and measures to improve mentioned sub-processes must be taken.

FIGURE 6: MEAN OF MANAGEMENT LEVELS AND ACTIVITY CAPABILITY INDICES OF WHITE GOODS SECTOR



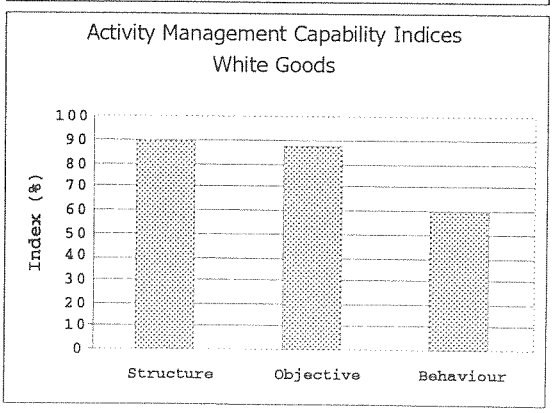
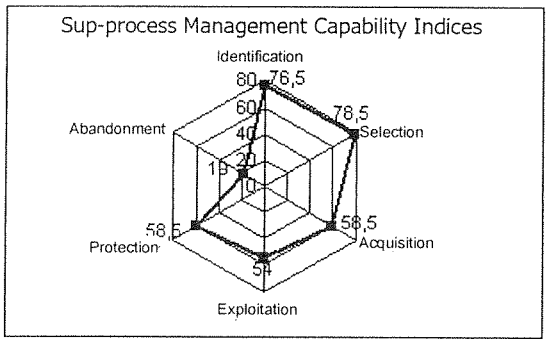
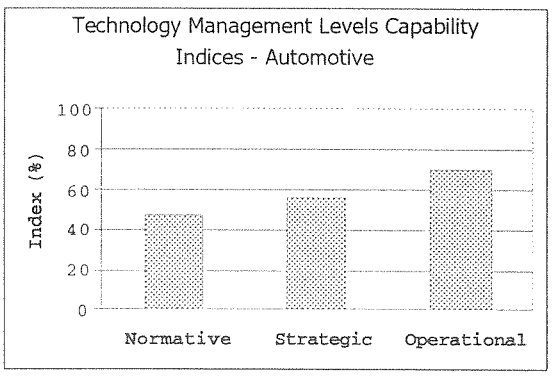


FIGURE 7: MEAN OF SUB-PROCESS MANAGEMENT CAPABILITY INDICES OF WHITE GOODS SECTOR



Extracting strategic directions from the normative considerations are achieved successfully in white goods sector. Although the strategic management capability is the highest compared with the other two sectors, the sector needs to define its strategic goals more clearly. Operational success can be attributed to the properly managed technology sub-process and to the success achieved in human-related issues. Small behaviour index denotes the weakness of company culture, organizational and individual learning practices and opportunities, management behaviours and communication principles in the firms belonging to this sector.

FIGURE 8: MEAN OF MANAGEMENT LEVELS AND ACTIVITY CAPABILITY INDICES OF AUTOMOTIVE SECTOR



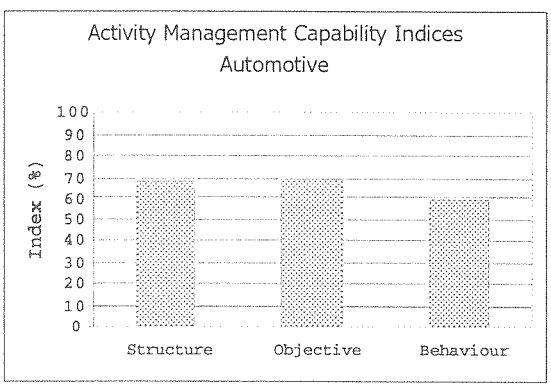
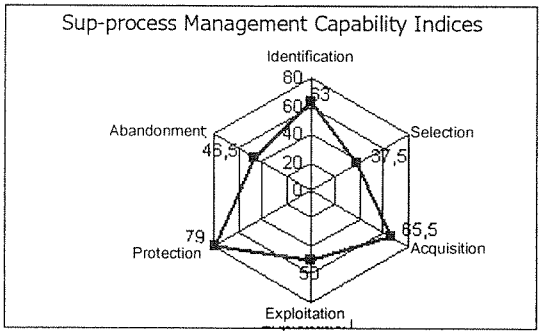


FIGURE 9: MEAN OF SUB-PROCESS MANAGEMENT CAPABILITY INDICES OF AUTOMOTIVE SECTOR



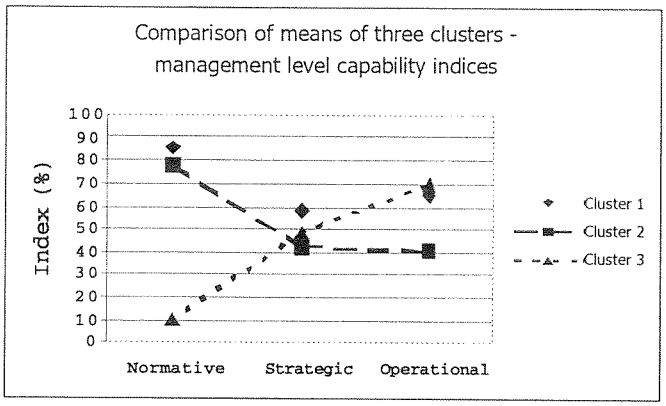
Automotive sector has a high strategic and operational level management capability indices, but normative considerations are not achieved successfully in the sector. The strategic power comes from the emphasis put on the sub-processes. Not to pursue the technological improvements related to the industry and being unaware of the technological change leads the sector to a weak selection process. Operational success can be attributed to the properly managed technology sub-processes and to the success achieved in human-related issues.

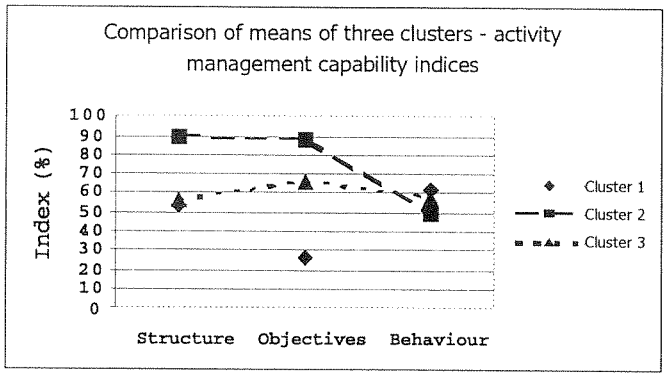
Clustering

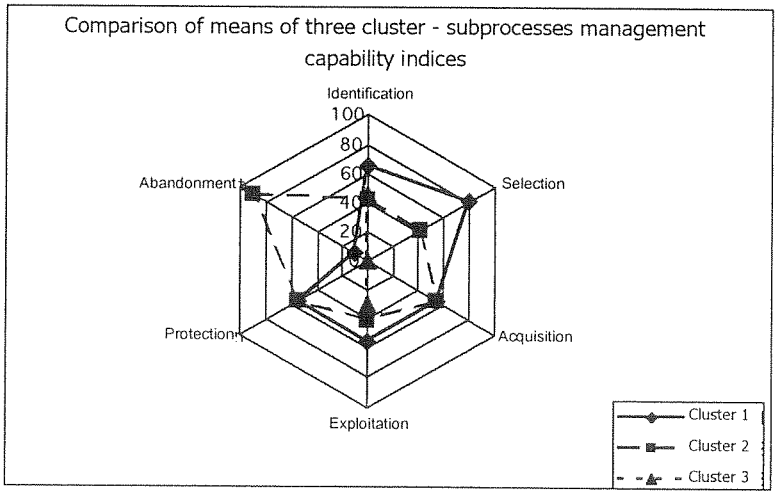
After examining each firm, the k-means cluster analysis was executed in SPSS. 3 clusters were formed for each set of indices, and the general trends of each cluster considering the mean values were investigated (Figure 10).

Upon calculation of average values of indices, we had the clues for the three sectors and we had a chance to compare these sectors with the machine manufacturing sector.

FIGURE 10: COMPARISONS OF CLUSTERS IN CAPABILITY INDEX SET







Cluster 1 has a relatively high capability in normative and strategic levels when means of three clusters are compared according to management level capability indices. It means that the firms in this cluster make their primary decisions according to long term goals of the company they belong. In other words, the firms in cluster 1 are more powerful than the firms in other clusters and it should be noted that all of the firms in cluster 2 are in the machine manufacturing sector. The firms in both cluster 1 and 2 are not that successful in transposing their business policies into comprehensible strategies (Figure 10). Strategic level objectives need to be reviewed. Operational issues are shaped by the strategic consideration. Because the strategic issues are not put proper emphasis in all sectors, operational level capability is influenced adversely.

The firms in cluster 1 belong to the machine manufacturing sector and this cluster has the lowest structure and objective capability indices when means of three

clusters are compared according to activity management capability indices. The reason of weakness for the firms belong to the machine manufacturing sector is the size of the firms. In this paper, the size of the firms were defined considering their number of employees. Majority of the machine manufacturing firms have employees less than 500. On the other hand, most of the firms belong to the electronics, white goods and automotive sectors have 2000 to 5000 employees.

In comparison of means of three clusters according to activity management capability indices, structures in all levels need to be enhanced and strategies must be developed according to business policy. Training activities and organizational learning should be put more emphasis in order to support business culture and operational strength.

All sectors need to be aware of the environmental developments, thus identification of emerging and new technologies should be put more emphasis. Selection among technological alternatives based on insufficient intelligence may cause failures in assimilation and exploitation of the obtained technology. Strategic weakness stems from deficiencies in managing sub-processes.

4. CONCLUSIONS

Having a potential to create technology generates the economic power of a country. The more a country creates its own technology, the more it is powerful economically. To create and operate technology determines a company's technological capability. The competitiveness of companies depends highly on these technological capabilities. Therefore, technology is one source of competitive advantage, which is also found in finance, marketing, distribution, and various other activities. However for firms that compete in a technological arena, industry leadership demands a technological competence that is sustainable. Of the factors that change the rules of competition, technological change is among the prominent.

As a competitive advantage, besides technology, another challenging factor to many companies is the integration of technology management systems into established business processes. Linking engineering, science and management disciplines in order to achieve objectives of the company requires effective management of technology. In this paper, the possible reasons of why some companies make use of technology and enhance their success more effectively than others were examined.

This paper was designed to assess technology management practices and draw technology management capability profiles of firms in automotive, white goods and electronics industries in Turkey. The model can be applied to any service and manufacturing sector regardless of the services and products.

Based on an improved process model (TPMCPM) of technology management, the research provided a means to assess the effectiveness of the critical technology management activities, and identify areas for improvement. The existence of high technology processes management capabilities within a firm implies that the firm has sufficient capabilities for integrating technology management with its business strategy and the firm views technology management as an integrated component of its general management.

Table 2 summarizes the steps of the suggested approach for the TPMCPM.

TABLE 2: STEPS OF SUGGESTED METHODOLOGY FOR ASSESSING THE TECHNOLOGY MANAGEMENT CAPABILITIES IN TURKEY

1. Provide a framework for linking technology with business needs,
2. Identify and evaluate the important technology management issues in the firm,
3. Identify areas of strength and weakness,
4. Make recommendations for action plans.

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