Technology Processes Management Capability Profiles of Machine Manufacturers in Turkey

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Abstract- Management of technology is gaining more importance worldwide and its acceptance is acknowledged by governments, industry and educational institutions. The economic strength of the countries depends on their ability to create their own technology and turn it into economic and social benefit. This research aims to assess technology management capabilities and draw capability profiles of machine manufacturing industry in Turkey. Developing 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. Technology Processes Management Capability Profiles Model (TPMCPM) integrates normative, strategic, and operational technology management levels with technology management sub-processes (identification, selection, acquisition, exploitation, protection, and abandonment of technology).

I. INTRODUCTION

Technology and coping with technological change have become prime factors for the competitiveness of companies and also of countries. Due to the far-reaching societal effects of technologies their deployment has even become a prime issue for the development of national economies. Technology management closes a gap within general management theory and practice by relating technological knowledge directly to management concepts [19].

For some reasons, some firms are successful in building their strategies around technology-based opportunities, while the others are not. In this research, the possible reasons that lead the firms to rapid growth, stagnation or decline will be examined in a process model framework.

This study aims the improvement of an existing methodology, developed by Gregory [7], enhanced and used by Ozgur [11] and Yuksel [22] for the assessment of technology management capabilities of the firms. The participant firms in the research belong to machine manufacturing industry in Turkey. The process model claims that if the firms have sufficient technology management capabilities, this will mean that they are adequately equipped to integrate their technology strategy with their business strategy or vice versa.

The first purpose of this study is to assess the technology management capabilities of machine manufacturing industry in Turkey and draw *technology processes management capability profiles*. The second purpose of the study is to diagnose and identify the actual reasons for deficiency in management of technology processes. The research will cover these steps:

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.

II. LITERATURE REVIEW

In a hyper-competitive environment, it has become imperative for practitioners and theoreticians to embrace the ultimate benefit of competition. The competitive challenge for manufacturers in the 21st century is flexibility, speed, responsiveness to the customer and integrating business strategies with technology strategies.

A. Competitive Strategy

Business strategies are formulated to determine the way in which organizations can move from their current competitive position to a new stronger one. Ma [8] defines competitive advantage as *the asymmetry or differential in any firm attribute or factor that allows one firm to better serve the customers than others and hence create better customer value and achieve superior performance*.

Chaharbaghi and Lynch [3] argue that strategic advantage explains how it can be sustained in dynamic business environments while competitive advantage is a static concept. Competitive advantage can only be sustained as long as this potential remains high [5].

Coates [4] argues that the specific goals of sustainability will also evolve as the world evolves, as an economy rises or falls in prosperity; as new technological, social, and economic factors come into play; as demographic patterns change.

B. Core Competences

Prahalad and Hamel [12] defined a core competency as *the collective knowledge in an organization about how to coordinate and integrate the multiple resources efficiently for product design and production*. *Changing, evolutionary, turbulent,* or *chaotic* describe the environment in which the businesses were competing [20]. Betz [2] appreciated the development of core competences as the determinant of why

some diversified firms have thrived, as others have died in 1990s.

Teece et al. [17] defined core competences as a firm's fundamental business and derived them by looking across the range of a firm's (and its competitors) products and services. Unland and Kleiner [20] defined a core competence as as an organization's collective learning; as communication, involvement and commitment without regard for organizational boundaries and as the skills of individuals who can blend their expertise with that of others in innovative ways.

Thompson and Richardson [18] have identified 30 organizational competences, which they argue, comprise a generic requirement for all organizations.

C. Role of Technology and Technology Management

It is widely accepted that technology is a source of competitive advantage [9]. Mitchell [10] states that despite the success of strategic planning and management systems throughout the 1970's and early 1980's, firms have often failed to give business management sufficient warning of major trends or opportunities arising from technology.

In order to deal successfully with the issues of technological change, and their impact on strategy, planning frameworks must recognize and integrate two very different perspectives – the business viewpoint and the technologist's viewpoint - into a single system for the strategic management of technology [15].

Probert et al. [13] 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.

Skilbeck and Cruickshank [14] state that, technology management includes activities which cut across intra-organizational boundaries and disciplines and may also span many businesses in order to create and sustain technology-based competitive advantage in a rapidly changing marketplace.

Tarr [16] argues that, beyond the innovative processes in R&D, the management of technology includes the controlled introduction and use of technology in products, manufacturing processes, and internal organizational functions. A key focus is the integration of technology into overall business operations instead of isolating the technology within special-purpose functions.

D. Integrated Technology Management

Tschirky [19] argues that, although companies create technology and are simultaneously most affected by technological change, this fact is not generally taken into account in general management textbooks. According to the author, 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 (Tschirky, 1997)

E. Technology Management Assessment

The framework proposed by Gregory [7] extends technology management beyond the domain of corporate needs and considers it as a collection of processes operating across the whole organization. His study identifies and draws together the key processes for technology management within the framework. Probert et al. [13] construct their practical management guide TMAP-Technology Management Assessment Procedure- based on the framework proposed by Gregory [7]. The framework groups technology management into five distinct process areas: identification, selection, acquisition, exploitation and protection of technology.

The same framework made the basis of two more researches done by Ozgur [11] and Yuksel [22]. The two authors added the sixth process of *abandonment* to the process model in their researches. Figure 2. shows the framework of Ozgur [11].

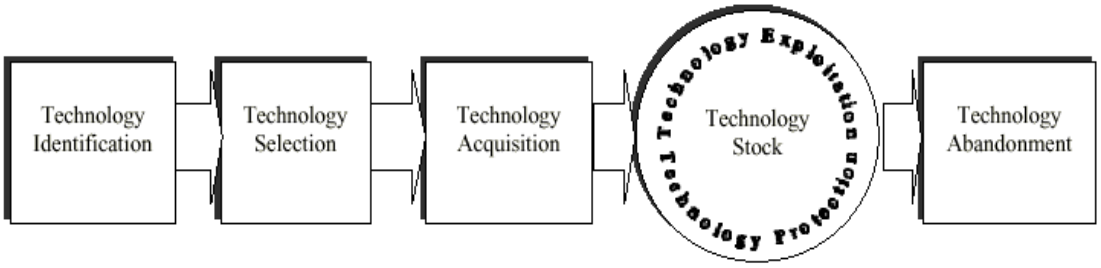

Figure 2. Six-process technology management framework (Ozgur, 1999)

III. MODEL AND RESULTS

A. Technology Processes Management Capability Profiles Model (TPMCPM)

The present research intends to improve the model of Yuksel [22] on the basis of an approach linking technology processes with management levels in order to assess technology management capabilities of machine manufacturing firms. Although the model can be applied to any service and manufacturing sector regardless of the produced services and products, in this research Turkish machine manufacturing sector was chosen for the detailed analysis and process model application.

TPMCPM 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 3.). The model intends to draw technology management capability profiles of Turkish machine manufacturing sector by scoring technology management practices of the firms in six sub-processes and in three management levels.

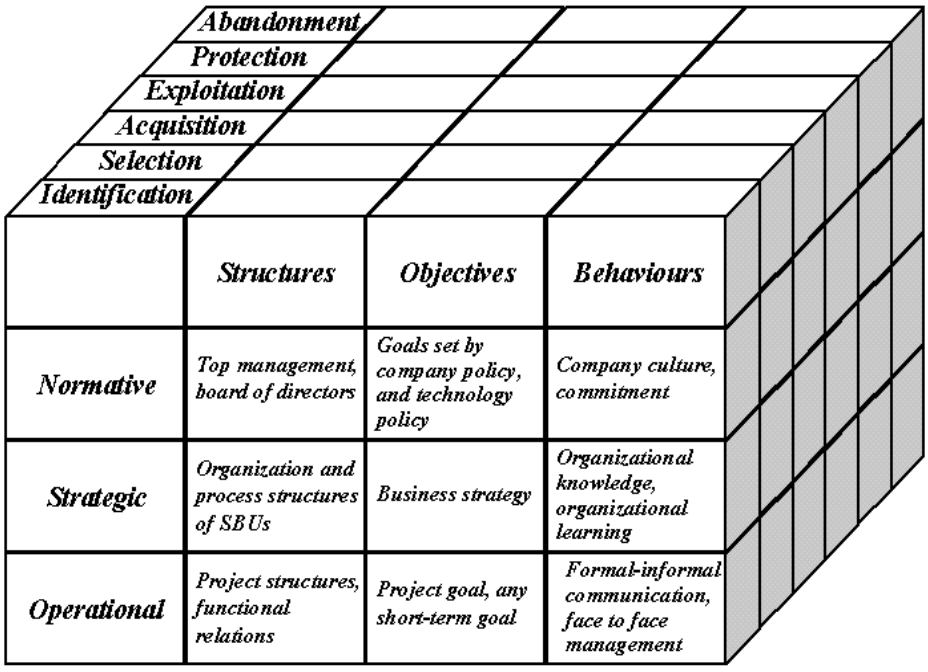

Figure 3. Framework of TPMCPM

B. Questionnaire

In this research, the survey instrument (questionnaire), used by Ozgur [11] and Yuksel [22], was improved based on the review of literature on technology management. The instrument was designed to collect data in order to assess technology management practices of the firms. Technology Processes Management Capability Questionnaire [21] was prepared including new additional sections.

The new version of the questionnaire was reviewed by several academic experts and managers at various firms. The reviewers were asked to critique the content, structure and relevance of the survey instrument.

To improve on the relevance and readability, the instrument was pre-tested on a group of 6 MIB-members located in Istanbul. The feedback obtained from the pretest study was used to refine the instrument significantly. Modifications were made to the questions wherever necessary to increase clarity of the survey instrument.

Coordinating with MIB management, the member firms to fill the questionnaire were selected. The firm size was measured as the number of employees in the company. Big-size companies have more than 500 employees while medium-size companies have between 100-499 employees and small-size companies have up to 99 employees. Respondents were companies' plant managers and general managers. These contact persons were advised to pass on the survey instrument (questionnaire) to knowledgeable management staff when appropriate.

In a letter accompanying the questionnaire, the broad areas encompassing *technology management processes* and *management levels* were identified in order to establish a common understanding of the processes and terms. 22 survey results out of 35 were received with a response rate of 63 per cent. 2 questionnaires were eliminated because the respondents failed to complete the questionnaire in its entirety. The remaining 20 (57 per cent) usable responses were included in the scoring and analysis.

C. Scoring of the Questionnaire

The *Technology Processes Management Capabilities Questionnaire* actually inquires capabilities of management at normative, strategic and operational levels by questioning practices related with technology management.

The challenging questions in scoring the practices were :"What are the contributions and importance weights of each sub-process to the overall success of the company? Which sub-process is more important for which industry? How do the firms score the sub-processes for their contribution to their success?" In order to learn how firms weigh the importance of each sub-processes (identification, selection, acquisition, exploitation, protection and abandonment) considering their contribution to the overall success of their firms, 200 firms from Turkey and Austria representing different industries were contacted via e-mail summarizing the explanation of each sub-processes and requesting the scoring of importance weights of each sub-process out of 100 points. 60 firms out of 200 returned their importance scorings. Table 1 shows the distribution of the responsive firms according to the industries they belong.

TABLE 1 DISTRIBUTION OF THE FIRMS WHICH SCORED THE SUB-PROCESSES

Sector	Country	Number of Firms	Percentage
Machine Tool	Austria	14	23.37
R&D Services	Turkey	4	6.
Automotive	Turkey	3	5.0
Electronics	Turkey	7	11.7
Petroleum Products	Turkey	6	10.0
Motor	Turkey	2	3.3
Defense	Turkey	5	8.3
Textile	Turkey	3	5.0
Chemical Products	Turkey	2	3.3
Metal	Turkey	5	8.3
Machine Manufacturing	Turkey	9	15.0
Total		60	100.0

TABLE 2 AVERAGE SCORINGS OF FIRMS FOR THE IMPORTANCE OF SUB-PROCESSES

Sector	*Country*	*Identification*	*Selection*	*Acquisition*	*Exploitation*	*Protection*	*Abandonment*
Machine tool	AU	***25.8***	*23.5*	*13.4*	*18.9*	*10.7*	*7.7*
R&D services	TR	*21.0*	*23.7*	*17.0*	*22.3*	*7.4*	*8.6*
Automotive	TR	*16.7*	*26.5*	*13.0*	*23.3*	*10.5*	*10.0*
Electronics	TR	*23.9*	*23.6*	*11.9*	*16.4*	*12.9*	*11.3*
Petroleum prod.	TR	*25.0*	*17.3*	***25.0***	*13.5*	*9.2*	*10.0*
Motor	TR	*21.0*	***28.5***	*13.0*	***12.5***	*10.0*	*15.0*
Defense	TR	*13.6*	*18.8*	*20.0*	*20.6*	*12.0*	*15.0*
Textile	TR	*16.0*	***12.0***	*13.0*	*18.0*	*9.0*	***32.0***
Chemical prod.	TR	*22.0*	*18.6*	*15.0*	***32.6***	***4.4***	***7.4***
Metal	TR	***12.0***	*25.0*	***8.0***	*20.0*	***16.0***	*19.0*
Machine manuf.	TR	*22.7*	*26.6*	*10.1*	*19.0*	*8.3*	*13.3*
Mean		*20.0*	*22.2*	*14.5*	*19.8*	*10.0*	*13.5*

Table 2 shows the average scores given to the sub-processes by the firms from different industries. Information gathered revealed that, the firms from different sectors appeared to put different importance weights on each sub-process.

The sectors giving the highest and lowest importance weights to each sub-process are shown on Table 2 in bold characters.

In scoring each of 6 sub-processes, the arithmetic average of the points which came from these 60 firms were used. Thus, TPMCPM uses the average scores of importance weights given by different sectors. The weights of the sub-processes which will be used in scoring of the machine manufacturing firms were identified as shown on Table 3. The questions examining relationship between technology and business strategies in general section of the questionnaire were given a total importance weight of 42 points considering their contribution to the overall success of the company. Considering 6 sub-processes and the supporting sections, the total important weights given reached to the total of 174.8 points (Table 3).

In each section, there are questions aiming to assess all management levels. Importance weights of each sub-process and the supporting section were categorized into the management levels, and total weights of management levels were identified (Table 3).

TABLE 3. IMPORTANCE WEIGHTS OF THE MANAGEMENT LEVELS

Section No:	Section	Total Weight	Normative Weight	Strategic Weight	Operational Weight
1	General	42.0	10.5	21.5	10.0
2	Engineering Capabilities	13.0	na	na	13.0
3	New Product Manufacturing	9.5	na	na	9.5
4	New Product Development	10.3	na	na	10.3
5	Identification	20.0	1.5	18.5	na
6	Selection	22.2	4.2	18.0	na
7	Acquisition	14.5	0.9	12.1	1.5
8	Exploitation	19.8	1.8	12.7	5.2
9	Protection	10.0	na	10.0	na
10	Abandonment	13.5	na	13.5	na
Total		174.8	18.9	106.3	49.5

Thus, each question has an importance weight according to the sub-process it supports. Upon assigning the importance weights for each question, the next step is to identify the scoring. Majority of the questions were structured in Likert scale having 5 scales (1: not important-or-do not agree; 5: very important-or-strongly agree). The weights of the questions were multiplied by the scale which the company selected.

Upon receiving the questionnaires from the respondent firms, each section of the questionnaire was subjected to reliability analysis in SPSS as a whole. All sections have an *alpha value* of more than 0.7, which indicates existence of reliability in the sections. The next step was executing factor

analysis by using SPSS package program on the questions. Each section of the questionnaire was subjected to factor analysis separately. Factor analysis in each section revealed that SPSS found different groupings of Eigenvalue over 1. *Principal Component Analysis* was used as extraction method and *Varimax with Kaiser Normalization* was used as rotation method. The groups constructed by SPSS factor analysis were subjected to reliability analysis separately. Results of reliability tests forced some questions to be altered or deleted. The results exhibited that some of the questions decreased the value of *Cronbach's alpha* lower than 0.7. Results of the factor analysis and reliability tests showed the need to exclude 3 questions from scoring process.

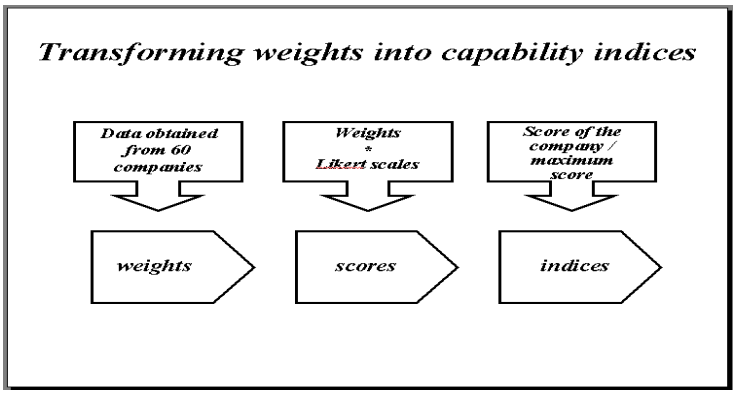

Figure 4. Basic Steps of Calculating Indices

Thus, the weights obtained from 60 firms lead us to scores by multiplying the weights by likert scales that the companies selected in the questionnaire. The scores lead us to the capability indices by dividing score of the company to maximum score.

Processing the answers of the companies leads us to the capability indices. The model identifies 3 sets of management capability indices.

First one is management levels capability indices. Here;

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. Upper decision-making levels of the company and their balanced representation of technical and non-technical abilities is the other factor having a major influence on 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 (such as R&D 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.

Second set of indices is the activity management capability indices. Here;

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.

Third set is sub-process management capability indices. Here; each index indicate the strength of company in managing related sub-process.

D. Results and Analysis

Upon the scoring process, TPMCPM identified 3 sets of technology management capability indices for each firm:

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).

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. The means of management capability indices of the participant

firms reveal the deficiencies in the sector (Table 4 and Figures 5, 6):

TABLE 4. MANAGEMENT LEVEL AND ACTIVITY CAPABILITY MATRIX OF THE SECTOR (MEAN)

		structures	objectives	behaviours
	Total	%49	%29	%60
Normative index	%81	%69	%85	%81
Strategic index	%47	%59	%22	%62
Operational index	%46	%38	%84	%49

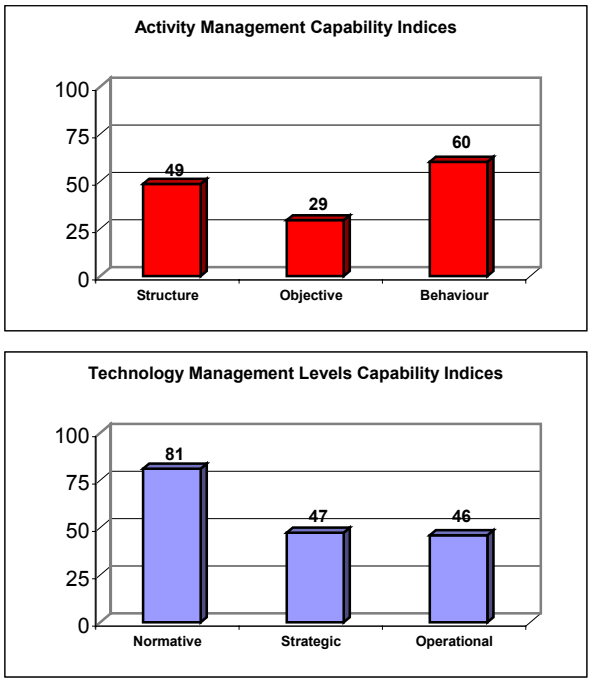

Figure 5. Mean of management levels and activity capability indices of the sector

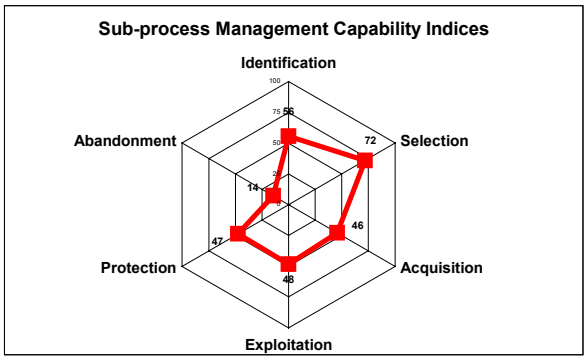

Figure 6. Mean of sub-process management capability indices of the sector

Machine manufacturing sector has a relatively high capability in normative level in which it makes its primary decisions according to long term goals of the company. (Table 4 and 5) The sector needs to enhance the integration of business and technical perspectives within the same strategic planning framework. Its objectives and strategy must remain consistent over time (which is not to say inflexible). Human related issues and business culture emerges as relatively powerful.

The sector is not that successful in transposing its business policy into comprehensible strategies (Fig. 5). 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 the sector, operational level capability is influenced adversely.

Structures in all levels need to be enhanced and strategies must be developed according to business policy.(Fig. 5) Training activities and organizational learning should be put more emphasis in order to support business culture and operational strength. Operational level of management can be improved by benefiting from advanced manufacturing technologies and improving employee capabilities (e.g., project management). R&D activities need to be paid more attention in the sector. The sector needs 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.

TABLE 5.CAPABILITY INDICES OF ALL FIRMS

Capability Indices of All Firms

Firm No	Management Capability Indices											
	Normative index	Strategic index	Operational index	Structure index	Objective index	Behaviour index	Identification index	Selection index	Acquisition index	Exploitation index	Protection index	Abandonment index
Firm 1	90	57	52	60	30	73	82	84	61	50	50	0
Firm 2	80	51	41	46	30	56	81	84	68	48	35	77
Firm 3	93	54	38	46	30	66	67	100	32	46	64	0
Firm 4	85	54	63	52	35	72	58	80	56	66	51	13
Firm 5	93	63	74	72	34	84	78	80	74	72	67	0
Firm 6	74	43	22	33	22	51	48	64	43	48	45	0
Firm 7	81	40	30	35	22	58	32	76	40	50	48	0
Firm 8	94	48	67	54	24	75	97	81	42	70	64	0
Firm 9	77	42	45	42	26	58	40	76	45	49	90	22
Firm 10	88	65	70	66	35	85	80	94	66	58	94	0
Firm 11	77	98	47	50	24	52	45	45	59	48	59	0
Firm 12	67	52	50	47	37	62	62	54	65	53	64	0
Firm 13	64	52	30	43	36	53	61	71	43	40	43	53
Firm 14	37	18	38	39	17	28	47	0	0	27	0	0
Firm 15	70	28	38	39	14	43	41	46	37	28	18	0
Firm 16	87	53	37	47	42	58	65	81	29	41	40	58
Firm 17	88	34	49	48	23	51	48	49	58	36	42	0
Firm 18	73	52	45	49	43	57	53	69	48	45	38	62
Firm 19	95	54	47	58	20	69	65	95	64	55	54	0
Firm 20	80	48	30	46	20	57	61	95	9	45	48	0

E. The Example of Firm 4

Each of the participant 20 firms gets the capability indices. And considering these indices, the firms were examined. For example; Firm 4 has a relatively high normative level capability in which it makes its primary decisions according to long term goals of the company. Although its business and technology policies are powerful, the firm needs to enhance the integration of business and technical perspectives within the same strategic planning framework (Figure 7, 8).

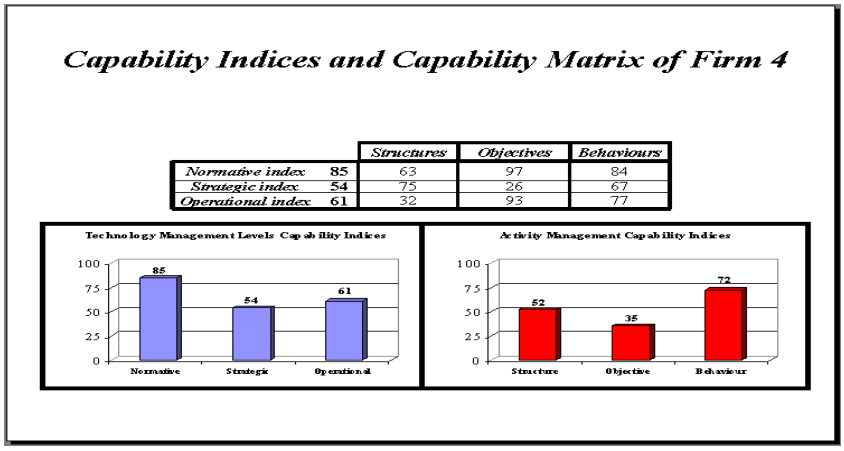

Figure 7 Capability Indices and Capability Matrix of Firm-4

But the firm is not that successful in transposing its company policy into strategies. Strategic level objectives need to be reviewed. Operational issues are shaped by the strategic consideration. The operational capability is higher than strategic level, which indicates the lack of harmony between two levels. Short term goals are pursued without considering strategic issues. The insufficiency in strategic level is stemmed from the deficiency in sub-process management.

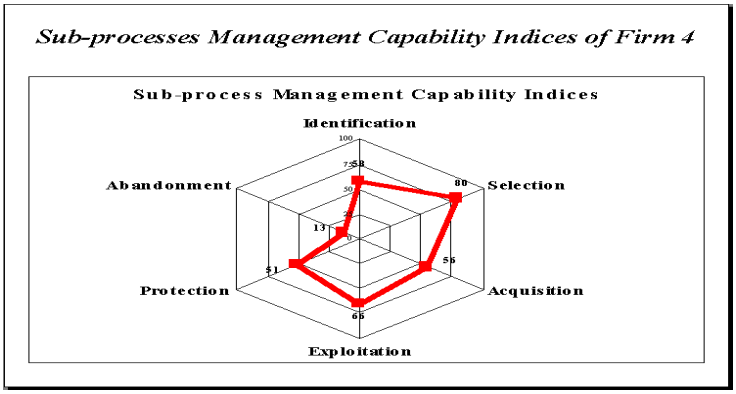

Figure 8 Sub-processes Management Capability Indices of Firm-4

Here it can be seen that technology intelligence activities are weak, and selection of technology is based on this insufficient knowledge on new technologies. The acquisition index indicate the weakness of R&D activities. Abandonment decision is also affected by the weak identification capability.

Structures of all kinds in the organization need to be reviewed and the barriers obstructing effective coordination and communication need to be overcome. Objectives, especially the strategic ones must be defined and pursued effectively. Although the behaviours index is relatively higher than the other activities, it can be enhanced by increasing learning and training activities.

F. Clustering The Firms

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 9).

Upon calculation of average values of indices, we had the clues for the sector. Machine manufacturing sector has a relatively high capability in normative level. The sector needs to enhance the integration of business and technical perspectives within the same strategic planning framework.

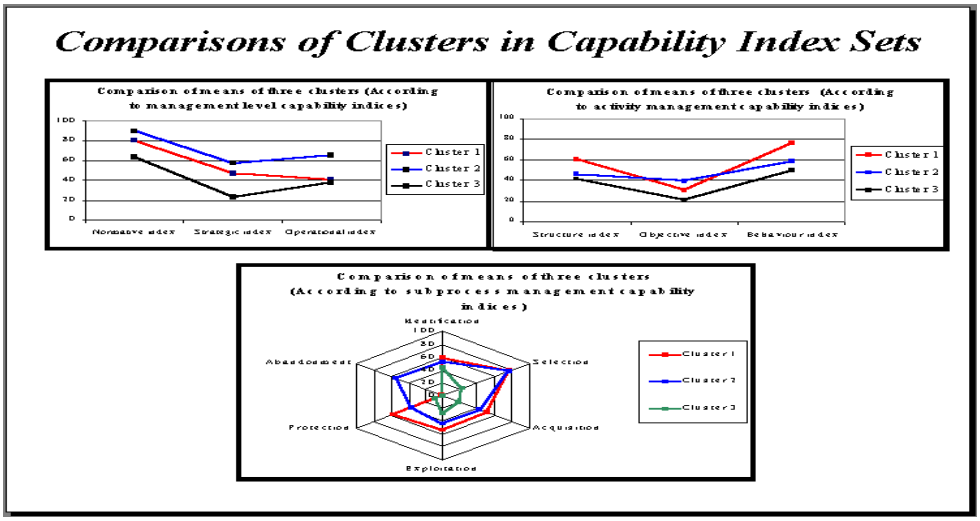

Figure 9 Comparisons of Clusters in Capability Index Sets

The sector is not that successful in transposing its business policy into comprehensible strategies. 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 the sector, operational level capability is influenced adversely. Operational level of management can be improved by benefiting from advanced manufacturing technologies and improving employee capabilities.

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.

Strategic weakness stems from deficiencies in managing sub-processes. The sector needs 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. R&D activities need to be paid more attention in the sector.

The firms in Cluster 3 may experience difficult times in the future considering their very low scores in all sub-process management capabilities indices.

IV. CONCLUSION

The economic power of the countries depends heavily on their ability to create their own technology. Similarly, the competitiveness of companies operating in technology intensive industries is becoming more and more dependent on their technological capabilities. 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 can change the rules of competition, technological change is among the prominent. Since, among core competences technological ones are the crucial, control over core technological competences is a secret of power and success in industry.

Although the effective application of technology is a key source of competitive advantage for modern industry, the integration of technology management systems into established business processes represents a continuing challenge to many firms.

This research was designed to assess technology management practices and draw technology management capability profiles of machine manufacturing industry 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.

TPMCPM intended to draw capability profiles of machine manufacturing firms in this research. Different sectors can be chosen for applying the process model in the future. In order to compare the results and improvements, this research should be applied again on the same industry sector (especially on the same participant firms) after a period of time.

In the scoring of the questionnaire, the research revealed different importance weights given to each sub-processes by different sector. The reasons for differences in each sector can be a research study in the future. The three capability indices (normative strategic and operational) can be unified in

a unique capability index in order to rank the participant firms by the future researchers.

The process model links technology processes with management levels in order to assess technology management capabilities of firms. Cross effect of levels on the same activity of technology management process makes the issue more complicated. Therefore, it has been decided that division of technology management process into sub-processes would make the analysis of these roles easier. TMPCPM includes the processes of technology identification, selection, acquisition, exploitation, protection, and abandonment as the sub-processes. TPMCPM groups *strategic* and *operational* levels of technology management under a higher *normative* level. The process model identifies three levels of management playing a role in the development and utilization of technology.

Based on the review of the literature on technology management, Technology Processes Management Capability Questionnaire [21] was prepared for obtaining data in order to assess technology management practices of the firms. A limitation might come from the use of questionnaire results. Even though the questionnaire methodology is the only way to collect a large sample of qualitative data, these data have limitations due to the subjective nature of the results. On the other hand, the respondents of this survey are mainly in top management and the positions of the respondents in the firms affirm the reliability and validity of the data obtained.

REFERENCES

[1] Abernathy, W.J. and Clark, K.B., 1985, "Innovation: Mapping the Winds of Creative Destruction", Research Policy, 14, p.3.

[2] Betz, F., 1994, Strategic Technology Management, McGraw Hill Book. Co., Singapore.

[3] Chaharbaghi, K. and Lynch, R., 1999, "Sustainable Competitive Advantage: Towards a Dynamic Resource-Based Strategy", Management Decision, 37(1), pp. 45-50.

[4] Coates, J.F., 1998, "Technology Assessment as Guidance to Governmental Management of New Technologies in Developing Countries", Technology Forecasting and Social Change, 58, pp. 35-46.

[5] Feurer, R. and Chaharbaghi, K., 1994, "Defining Competitiveness: A Holistic Approach", Management Decision, 32(2), pp. 49-58.

[6] Frohman, A.L., 1985, "Putting Technology into Strategic Planning", California Management Review, 27(2) (Winter), pp. 48-59.

[7] Gregory, M.J., 1995, "Technology Management: A Process Approach", Proceedings of the Institution of Mechanical Engineers, 209, pp. 347-356.

[8] Ma, H., 1999, "Creation and Preemption for Competitive Advantage", Management Decision, 37(3), pp.259-266.

[9] Maidique, M.A., and Patch, P., 1988, "Corporate Strategy and Technology Policy", in Readings in the Management of Innovation, M.L. Tushman and W.L. Moore (eds.), Second Edition, Ballinger, Cambridge, MA., pp.236-248.

[10] Mitchell, G.R., 1990, "Alternative Frameworks for Technology Strategy", European Journal of Operational Research, 47, pp. 153-161.

[11] Ozgur, A., 1999, "A Process Model for Technology Management", M.S Thesis, Boğaziçi University, İstanbul.

[12] Prahalad, C.K. and Hamel, G., 1990, "The Core Competence of the Corporation," Harvard Business Review, 78(3), pp. 79-91.

[13] Probert, D.R., Phaal, R. and Farrukh, C.J.P., 2000, "Development of a Structured Approach to Assessing Management Practice", Paper submitted to Proceedings of the Institution of Mechanical Engineers.

[14] Skilbeck, J.N. and Cruickshank, C.M., 1997, "A Framework for Evaluating Technology Management Processes in Technology Based Businesses", Proceedings of the Portland International Conference on Management of Engineering and Technology (PICMET), 27-31 July 1997, Portland.

[15] Steele, L.W., 1975, Innovation in Big Business, Elsevier, New York, NY.

[16] Tarr, S.C., 1991, "Multiple Perspectives Analysis for Integrating Technology into a Business", Technological Forecasting and Social Change, 40, pp. 165-182.

[17] Teece, D.J., Pisano, G. and Shuen, A., 1997, "Dynamic Capabilities and Strategic Management", Strategic Management Journal, 18, pp. 509-33.

[18] Thompson, J. and Richardson, B., 1996, "Strategic and Competitive Success: Towards a Model of the Comprehensively Competent Organization", Management Decision, 34(2), pp. 5-19.

[19] Tschirky, H., 1997, "Bringing Technology into Management: The Call of Reality Going Beyond Industrial Management at the ETH", Proceedings of Portland International Conference of Engineering and Technology (PICMET), 27-31 July 1997, Portland.

[20] Unland, M. and Kleiner, B.H., 1996, "New Developments in Organizing Around Core Competences", Work Study, 45(2), pp.5-9.

[21] Yıldırım, O.U., Oner, M.A. and Başoğlu, N., 2000, "Technology Processes Management Capabilities Questionnaire", Internal Report, Management and Technology Strategies Joint Research Group, Boğaziçi University and Yeditepe University, İstanbul.

[22] Yuksel, B., 2000, "Technology Management Capability Profiles as Obtained From The Analysis and Modelling of Integrated Technology Management Processes: The Case Automotive Suppliers Industry and Supermarkets in Turkey", M.S. Thesis, Marmara University, İstanbul

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