TECHNOLOGY MANAGEMENT AND THE LINK WITH TECHNOLOGY STRATEGY AND COMPANY PERFORMANCE

Theuns G. Pelser and J. J. Prinsloo

ABSTRACT

The role of the top manager in technology intensive industries has become much more multidimensional and multi-disciplinary. A critical concern of this discipline is optimising returns to the company's stakeholders over the long term. This means sustaining performance by balancing strategic investments in technology with short-term profitability. The purpose of this study was to investigate technology management principles in widespread use in technology intensive industries and to explore their relationship to company performance. A non-probability, judgment sample of companies listed on the Johannesburg Stock Exchange (JSE) were taken. The study makes a contribution to the field of strategic management research by integrating the dimensions of several previous studies, to derive a more comprehensive taxonomy of technology management archetypes. Two distinct technology management factors obtained with the analysis were proved to positively influence the company performance dimensions and were classified as R&D Commitment and Control Market Planning factors. The results show that strategic management choices can significantly affect company performance. It thereby indicates which of the underlying dimensions have the strongest relationship with company performance.

Keywords: Technology Management; Company Performance; Control Market Planning; Process Management; R&D Commitment.

INTRODUCTION

Pelser (2001) argues that technology plays an essential role in interactions among the individual, society and nature. Technological advances have major effects on each of these entities and are, in turn, influenced by them. Management of technology involves developing an understanding of these relationships and dealing with them in a rational and effective manner. The widely acknowledged importance of technology will grow; increasing the emphasis top managers must place on their companies' ability to compete through

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technology (Nambisan & Wilemon, 2003).

The 2011-12 R&D survey, conducted by the Human Sciences Research Council (HSRC, 2014), shows that South Africa's performance remains far below the government's initial target of spending 1% of GDP on R&D by 2008. South Africa had spent R22.2bn on R&D in 2011-12, or 0.76% of GDP. This was precisely the same ratio reported for 2010-11, and is noticeably down on previous surveys: it was 0.87% in 2009-10, 0.92% in 2008-09 and 0.93% in 2007-08. These findings emulate the global trends of slowing growth in R&D investment in many parts of the world as a result of the recent global financial crisis. Unfortunately for South Africa, it also trails far behind the international average of 1.77%, and lags most of the other members of BRICS (an association of five major emerging national economies: Brazil, Russia, India, China and South Africa).

The progressiveness of technology management, however, goes beyond basic research and development (R&D) expenditures. Increasingly, corporate strategists are focusing on the integration of technology throughout the organisation as a source of sustainable competitive advantage (Song, Zhao & Di Benedetto, 2013). This particular study builds on the previous works of Pelser (2014a, 2014b, 2014c, 2014d, 2014e) regarding strategy taxonomies and their link to company performance.

LITERATURE REVIEW

According to Thongpapanl (2012), the management of technology links engineering, science, marketing, operations, human resources and other management disciplines to formulate strategy, develop technological capabilities and apply them to achieve strategic objectives. This study follows the usage of Clark, Ford & Saren (1989), who use the term to refer to the organisational issues and the processes involved in developing and implementing a strategic approach to technology. Technology management thus relates to the process aspects of technology policy (Harmon, & Davenport, 2007).

The strategic approach has evolved from the control paradigm, which argues for an integration of technology with corporate strategy (Pelser, 2001). Technology has been seen as an essential component of the strategy and forms part of the strategic thinking and planning process (Pelser, 2014a). Companies will concentrate on constantly refining their abilities to acquire and deploy relevant technologies, which will be treated as an integral part of their corporate strategies. The technology leaders will be faced with technology acquisitions and deployments. Hence, sustainable competitive advantage will be realised only from the company's ability to become skilled at the technology acquisition and deployment tactics (Pelser, 2014a, 2014b, 2014c, 2014d).

Technology Performance Measurement

Hansen (2010, p. 17) remarks, that in many manufacturing companies' managers do not have adequate measures for evaluating company performance or for comparing overall performance from one subsidiary to the next. The author go further by stating that the traditional cost-accounting figures can be used, but that these figures do not represent the true nature of company performance. What Hansen (2010) found even more disturbing, is that private sector accounting systems, as traditional management information systems, which are supposed to represent the organisational reality, are problematic themselves.

Zahra & Hayton (2008) established that the literature on performance is very extensive, but that it shows a lack of consensus as to the meaning of the term. Brush & Vanderwerf (1992) further point out, that the use of the term "performance" by researchers, includes many constructs measuring alternative aspects of performance. This is consistent with the finding of Murphy *et al*., (1996) who, after a comprehensive literature review, were able to isolate a total of 71 different measures of performance.

Technology Management Dimensions

This study follows the usage of Clark *et al*., (1989, p. 215), who used the term *management of technology* (MOT) to refer to the organisational issues and the processes involved in developing and implementing a strategic approach to technology. Technology management is measured through the use of the following six process or technology management dimensions (Pelser, 2001):

1. *Technology awareness refers to a company's scanning processes, specifically the emphasis it places on acquiring information about emerging technological threats, opportunities and sources (Clark et al., 1989; Dvir et al., 1993). It is measured in terms of the emphasis placed on staying informed about emerging technologies or competing technologies and the awareness of different technology sources.*
2. *Technology acquisition refers to the methods by which companies acquire technology internally or externally (Maidique & Patch, 1988; Clark et al., 1989). It is measured in terms of the emphasis a company places on acquiring technology from internal R&D activities and from external research institutes or other companies.*
3. *Technology and product planning refers to the formal planning processes that companies utilise to select and manage R&D programs (Maidique & Patch, 1988). According to Lee, Yoon, Lee, & Park (2009) technology planning involves the reformulation of technical terms and objectives into business terms and objectives. It is measured in terms of the emphasis a company places on formal product plans that are market-driven and formal technology plans that are product-driven.*
4. *R&D organisation and management refers to the degree to which R&D activities are linked to other business operations and the methods companies employ to organise, empower and encourage R&D personnel (Eng & Ozdemir, 2014; Maidique & Patch, 1988). It is measured in terms of the emphasis a company places on integrating R&D operations into product division operations and managing R&D personnel based on R&D project success (Van Aduard de Macedo-Soares, Mayrink & Cavalieri, 2009).*
5. *R&D investment refers to the methods by which companies fund R&D activities (Tsai, Hsieh & Hultink, 2011) and the emphasis placed on achieving a specified return on investment (Clark et al., 1989; Yüce & Zelaya, 2014). It is measured in terms of the level of investment the company commits to R&D activities relative to sales and the emphasis placed on achieving financial leverage for R&D investments through external funding.*
6. *Manufacturing and process technology refer to the degree to which new technology is incorporated into the company's manufacturing plants and processes (Zahra & Covin, 1993). The appropriate manufacturing technologies can provide the company with considerable operational and competitive benefits (Sohal, 1995). It is measured in terms of the emphasis a company places on the use of technology to achieve low manufacturing costs or to manufacture unique products and to improve production flexibility or reduce lead-times.*

Company Performance

Zahra & Hayton (2008) recognized that the literature on performance is very wide, but that it shows a lack of agreement as to the meaning of the term. Brush & Vanderwerf (1992) indicate that the use of the term "performance" by researchers includes many constructs measuring alternative aspects of performance. This is consistent with the findings of Murphy, Trailer and Hill (1996) who, after a comprehensive literature review, were able to isolate a total of 71 diverse measures of performance.

Despite the fact that financial performance is obviously important for the company, it draws only on the economic dimension of performance, neglecting other important goals of the company (Venkatramen & Ramanjan, 1986). This argument is supported by Zahra & Covin (1994), who argues that research that considers only a single performance dimension or a narrow range of performance constructs (e.g. multiple indicators of profitability), may result in misleading descriptive and normative theory building. According to the author of this study, it is unlikely that any single performance measure or dimension could serve the needs of a diverse set of research questions. This view is also shared by Zahra & Hayton (2008), who points out, that a multi-dimensional construct provides an alternative in establishing valid operational definitions. Further to this, Murphy *et al*. (1996) argue, that a distinction between performance measures should be done on the grounds of whether the sources are secondary data (also known as archival) versus primary data (e.g. questionnaire interview).

PROBLEM STATEMENT AND RESEARCH QUESTIONS

There is a critical need to understand the key factors that lead to innovation excellence, the organisational and environmental innovation, and the importance of innovation strategies (Pelser, 2014a, 2014b, 2014c, 2014d). The main purpose of this study is to investigate technology management principles in widespread use in technology intensive industries and to explore their relationship to company performance. The problem addressed in the study, is the need for a better understanding of the role that technology management play in determining company performance. The study focuses on two central questions:

1. What is the prevalent technology management dimensions being employed by South African companies in technology intensive industries?
2. What relationships can be observed between the technology management dimensions and company performance?

RESEARCH METHODOLOGY

The data gathering and analysis phase of the study adheres to the same methodology as applied by Pelser (2014a, 2014b, 2014c, 2014d) regarding strategy taxonomies and their link to company performance and had the following three objectives:

1. Gathering data along key technology management dimensions from R&D managers of technology intensive companies.
2. Gathering objective data about the performance (input & output) of those companies selected for the study.
3. Analysing the data using multivariate statistical methods to explore the relationships among the technology management dimensions and company performance.

Data Requirements

The number of dimensions historically used to develop strategy taxonomies and the variables required to describe them, have varied by researcher (Pelser, 2001). When Miller & Friesen (1977) derived their strategy taxonomies in 1977, they gathered data on 31 variables representing four categories of adaptive behaviour (later classified as strategy dimensions). Galbraith & Schendel (1983) gathered data on 26 variables using the PIMS database. Snow & Hrebiniak (1980) used a 145 item questionnaire to gather data that were subsequently reduced to ten distinctive competence variables and one performance ratio prior to analysis. Cool & Schendel (1987) developed 15 scope and resource commitment dimension variables based on data drawn from a large variety of databases. Fiegenbaum & Thomas (1990) used seven scope and resource deployment dimensions and six performance variables that reduced to three performance ratios. Zahra & Covin (1993) used four dimensions to develop five business strategy archetypes and three dimensions to represent technology strategy. Dvir, Segev & Shenhar (1993) used Miles & Snow's (1978) four strategy archetypes and two strategy variables.

Several of the seminal studies on strategic taxonomies gathered research data in the form of management perceptions of their company's objectives or capabilities relative to some benchmark, e.g. the competition's objectives or capabilities (Hong, Hang & Jackson, 2011 and Pelser, 2001). This is consistent with the method recommended by Galbraith & Schendel (1983) and Panagiotou (2007), and is the method employed in the present study. This method also lends itself to answers that can be provided on a normalised five point Likert Scale, with "three" valued answers being "neutral" or "at the industry norm".

A survey of R&D managers of companies listed on the Johannesburg Stock Exchange (JSE) was conducted through the use of a questionnaire. The South African context was chosen both from an operational purpose and the objective to compare the findings with those obtained from studies conducted in other countries or regions. Since the performance of companies in technology intensive industries could be more affected by technology policies than by the performance of companies in other industries, it was assumed that companies in technology industries would be more likely to have technology strategies, thereby making it easier to observe the relationships of interest. R&D managers from 200 South African technology intensive companies were asked to complete a self-administered electronic questionnaire designed to gather data regarding their company's technology policies. The questionnaire requested data on the specific industry in which the company operates, the technology and innovation strategy of the company and the processes the company employs to develop and implement the strategy. Eighty-four valid responses were ultimately received and used in the study.

Sample Selection

A non-probability, judgment sample of companies listed on the Johannesburg Stock Exchange (JSE) was taken. It was decided to use listed companies on the JSE for two primary reasons: (1) Listed companies display a capacity and capability (capital and human resources) for R&D activities compared to smaller unlisted companies. (2) Quantifiable data (e.g. annual reports) is more readily available for the external stakeholders of listed companies than it is on unlisted companies. Two hundred companies or divisions were identified and incorporated in the survey after the screening stage. Feedback was received from 89 R&D managers of these two hundred companies, stating their willingness to participate in the survey. A total of 84 completed responses were received and captured for the study. This translates to a 42% response rate from the base of 200 originally identified companies.

ANALYSIS OF RESULTS

Factor Analysis: Technology Management

Twelve technology management variables (A11, A12 and A21 – A30), were factor-analysed by using the principal axis factoring method. Then using the latent root criterion, three factors were extracted on the basis of their Eigenvalues being greater than 1. Together they accounted for 78.81% of the variation in the data. The factors were rotated by using the Varimax rotation method. The correlation matrix for the twelve management variables was reviewed to confirm the existence of a substantial number of correlations, which indicates the existence of common factors. The technology management variables had correlations greater than .26 and more than 60% of the matrix elements were greater than .50. Bartlett's test of sphericity confirmed, that the correlation matrix was not an identity matrix. The Kaiser-Meyer-Olsen (KMO) measure as sampling adequacy was .756, which Hair *et al.*, (1998) characterised as "middling". This is also defined as an adequate measure, indicating that the degree of correlation between the unique factors was low.

The Chi-square statistic was 922.647 with 66 degrees of freedom, which is significant at the .000 level. The reduced set of variables collectively meets the necessary threshold of sampling adequacy and thus the fundamental requirements for factor analysis. The reproduced correlation matrix contained 12 residual values (18%) greater than .05, indicating that the model fits the data. The rotated technology management factor loadings are contained in Table 1. As a reminder, each respondent was asked to report on the importance of each of the variables to his or her company relative to major competitors. The heaviest factor loading for each variable is formatted in bold font style.

Table 1: Rotated Technology Management Factor Matrix

Variable	*Variable Description*	*Factor 1*	*Factor 2*	*Factor 3*
A22	Awareness of technologies	**.954**	.165	.054
A21	Awareness of technology sources	**.904**	.225	-.018
A25	Using formal product plans	**.758**	.466	.092
A24	External technology acquisition	**.729**	.319	-.042
A23	Internal technology acquisition	**.727**	.366	.103
A26	Using formal technology plans	**.657**	.389	-.101
A27	Integrating R&D operations	.350	**.821**	.069
A29	High level of R&D investment	.329	**.732**	.121
A30	External funding for R&D	.160	**.674**	-.193
A28	Evaluating & rewarding R&D personnel	.370	**.662**	-.039
A11	Technology and manufacturing	-.004	-.133	**.950**
A12	Technology and production flexibility	.036	.075	**.856**

All of the primary factor loadings used in the factor interpretation exceeded .50 in value. According to Hair *et al.* (2010), factor loadings greater than ±.30 are considered to meet the minimal level; loadings of ±.40 are considered important; and if the loadings are ±.50 or greater, they are considered more important.

1. R&D Commitment – The Eigenvalue of the first factor was 5.729. The technology awareness variables (A21-A22), technology acquisition variables (A23-A24) and the technology and product planning variables (A25-A26) loaded heavily on this factor. Taken together, these patterns of factor loadings clearly reflect the aggressiveness of a company's R&D commitment.
2. Control Market Planning – The Eigenvalue of the second factor was 2.889. The R&D organisation and management variables (A27-A28) and R&D investment variables (A29-A30) loaded heavily on this factor, indicating the degree of researcher empowerment, researcher rewards and integration of R&D with the business units.
3. Process Management – The Eigenvalue of the third factor was 1.806. The manufacturing and process technology variables (A11-A12) both loaded heavily on this factor. This indicates that the underlying factor relates to the company's manufacturing and technology processes.

Factor Analysis: Company Performance

The methodology for factor analysing the dependent variables, was similar to that used for the previous sections. Six company performance variables (B31 – B36) were factor-analysed by using the principal axis factoring method. Then, using the latent root criterion, two factors were extracted on the basis of their Eigenvalues being greater than 1. Together they accounted for 75.80% of the variation in the data. The factors were rotated by using Varimax rotation method.

Based on the Kaiser criterion of selecting factors with Eigenvalues greater than 1, the number of factors to be extracted, were set at two. However, the scree test indicates, that three factors would be retained. In combining these two criteria, two factors were eventually retained for further analysis, because of the very low Eigenvalue (.538) for the third factor. The Chi-square statistic was 235.832 with 15 degrees of freedom, which is significant at the .000 level. The reduced set of variables collectively meets the necessary threshold of sampling adequacy and thus the fundamental requirements for factor analysis.

The final statistics showed, that 75.80% of the variance was explained by the two factors. The reproduced correlation matrix contained 3 residual values (20%) greater than .05, indicating that the model fits the data. The rotated company performance factor loadings are contained in Table 2. The heaviest factor loading for each variable is formatted in bold font style.

Table 2: Rotated Company Performance Factor Matrix

Variable	*Variable Description*	*Factor 1*	*Factor 2*
B32	Efficiency of innovation project management	**.841**	.308
B33	Impact of the innovations	**.797**	.213
B31	New product contribution to sales	**.773**	.188
B34	R&D expenditure	**.756**	.123
B35	Patents registered	.089	**.762**
B36	Return on assets	.308	**.619**

All of the primary factor loadings used in the factor interpretation, exceeded .50 in value. Considering the factor loadings, the rotated factors are interpreted below:

1. Input Performance – The conceptual definition for this factor is the extent to which the R&D manager or other top manager perceives the innovation management organisation has achieved its desired objectives over the last three years. The Eigenvalue of the first factor was 3.167. The four input variables (B31 – B34) loaded heavily on this factor. Taken together, this pattern of factor loadings clearly reflects the effectiveness of the innovation management organisation (IMO).

2. Output Performance – This factor represents the performance of the company where (1) patent information was used to measure R&D activities and (2) return on assets (ROA) was used to measure company financial performance. The Eigenvalue of the second factor was 1.381. The patent's registered variable (B35) and the return on assets variable (B36) loaded heavily on this factor, indicating the degree of fit for this performance measure.

Reliability and Validity

The consistency of the survey data was assessed by using Cronbach's coefficient alpha, which measure the consistency of the entire scale. The Cronbach alpha computations for the five extracted factors are shown in Table 3. For the R&D commitment it is .9367; for the control market planning it is .8601; for the process management it is .8826, and for the input performance it is .8887. These high values indicate a high degree of data stability.

The factor analysis found relatively high degrees of communality among the variables. Most of the dimension variables have communalities greater than 0.5. The clear patterns of the factor loadings on the variables further validated the content and process constructs.

Table 3: Reliability Analysis

Variable	*Scale mean if item deleted*	*Scale variance if item deleted*	*Corrected item total correlation*	*Alpha if item deleted*	*Alpha*
			R&D Commitment (R&D)		
A21	17.6667	29.9598	.8716	.9177	
A22	17.5595	30.1289	.8882	.9161	
A23	18.2500	30.4307	.7744	.9298	**.9367**
A24	18.3095	29.3247	.7845	.9296	
A25	17.7857	31.3993	.8470	.9221	
A26	17.9286	30.5972	.7368	.9349	
			Control Market Planning (CMP)		
A27	9.9048	10.0390	.7991	.7864	
A28	10.2262	9.6952	.6981	.8264	**.8601**
A29	10.1310	9.4646	.7346	.8102	
A30	10.3810	11.2266	.6083	.8593	
			Process Management (PM)		
A11	3.0476	1.2266	.8108	-	**.8826**
A12	3.2857	1.9415	.8108	-	
			Input Performance (InP)		
B31	6.9405	13.3820	.7446	.8617	
B32	7.1429	13.0637	.8234	.8305	**.8887**
B33	7.6548	13.1685	.7540	.8584	
B34	7.8333	15.1044	.7130	.8741	
			Output Performance (OutP)		
B35	21.2381	151.9185	.5015	-	**.4104**
B36	2.4524	11.6724	.5015	-	

Multiple Regression Analysis

To ascertain the relative importance of the factors in explaining the variation in the dependent variables, multiple regression analysis was used to analyse the relationship between the dependent variables and independent variables. The Pearson r-correlations were calculated to find the strength and direction of the relationships between the factors and the performance dimensions.

By using p-values, it was possible to distinguish between the levels of significance. From Table 4 the null-hypothesis was rejected ($p < 0.05$ or $p < 0.01$) for all the factor correlations except for the Process Management factor ($p > 0.05$ or $p > 0.01$).

It is apparent that both the R&D Commitment and Control Market Planning factors have a significant positive effect on Input and Output Performance.

The level of relationship (R^2 or Rsq) that can be detected reliably with the proposed regression analysis was calculated to indicate the percentage of total variation of the Input Performance factor (InP). The Control Market Planning (Rsq = 0.5344) factor explains 53% of the total variation of the Input Performance factor. It means that the degree of researcher empowerment, researcher rewards, the integration of R&D with the business units and the level of R&D investment, determine the variation of the company's contribution to sales, efficiency of innovation project management, impact of the innovations, and R&D expenditure. The R&D Commitment factor (Rsq = 0.3352) explains 34% of the total variation of the Input Performance factor. It means that the aggressiveness of a company's R&D investment and the emphasis it places on integrating R&D operations, determine the variation of the company's contribution to sales, efficiency of innovation project management, impact of the innovations and R&D expenditure. The Process Management (Rsq = 0.0380) factor explains 4% of the total variation of the Input Performance factor. It means, that the emphasis a company places on manufacturing flexibility and technology processes, determines the variation of the company's contribution to sales, efficiency of innovation project management, impact of the innovations, and R&D expenditure.

Table 4: Correlation Matrix

		R&D Commitment	Control Market Planning	Process Management	Input Performance	Output Performance
R&D Commitment	Pearson Correlation	1.000	.638*	.012	.579*	.710*
	Sig. (2-tailed)	.	.000	.917	.000	.000
	N	84	84	84	84	84
Control Market Planning	Pearson Correlation	.638*	1.000	-.039	.731*	.382*
	Sig. (2-tailed)	.000	.	.721	.000	.000
	N	84	84	84	84	84
Process Management	Pearson Correlation	.012	-.039	1.000	-.195	-.030
	Sig. (2-tailed)	.917	.721	.	.075	.788
	N	84	84	84	84	84
Input Performance	Pearson Correlation	.579*	.731*	-.195	1.000	.435*
	Sig. (2-tailed)	.000	.000	.075	.	.000
	N	84	84	84	84	84
Output Performance	Pearson Correlation	.710*	.382*	-.030	.435*	1.000
	Sig. (2-tailed)	.000	.000	.788	.000	.
	N	84	84	84	84	84

* Correlation is significant at the 0.01 level (2-tailed).

The level of relationship (R^2 or Rsq) that can be detected reliably with the proposed regression analysis was calculated for the creation of the Output Performance model. The Control Market Planning (Rsq = 0.1459) factor explains 15% of the total variation of the Output Performance factor. It means that the degree of researcher empowerment, researcher rewards, the integration of R&D with the business units, and the level of R&D investment, determine the variation of the company's contribution to R&D activities (patents registered) and the company's efficiency in using its assets (return on assets). The R&D Commitment (Rsq = 0.5041) factor explains 50% of the total variation of the Output Performance factor. It means, that the aggressiveness of a company's R&D investment and the emphasis it places on integrating R&D operations, determine the variation of the company's contribution to R&D activities (patents registered) and the company's efficiency in using its assets (return on assets). The Process Management (Rsq = 0.0900) factor explains only 0.1% of the total variation of the Output Performance factor. It means, that the emphasis a company places on manufacturing flexibility and technology processes, have relatively no impact on the variation of the company's contribution to R&D activities (patents registered), and the company's efficiency in using its assets (return on assets).

MANAGERIAL IMPLICATIONS

The role of the top manager in technology intensive industries has become much more multidimensional and multi-disciplinary. This is recognized by assigning both the R&D Commitment and Control Market Planning factors to the top manager and top management team functions. These two functions are responsible for the formal technology policy within the company, with the objective to manage technical risk, increasing the sophistication of technology components utilised and the number of technologies in which the company maintains competence. Furthermore, they should be conscientious with encouraging researcher empowerment, the vast integration of R&D with the company's business units and a high level of R&D

investment.

The R&D Commitment factor reflects the aggressiveness of a company's R&D commitment and the emphasis it places on integrating R&D operations. It mirrors the organisational issues and the processes involved in developing and implementing a strategic approach to technology. Companies, who have loaded heavily on this factor, emphasise acquiring information about emerging technological threats, opportunities and sources. Furthermore, these companies express the need for acquiring technology from internal R&D activities and/or external sources. The majority of the respondents have indicated, that the principal form of R&D applied for technology acquisition and assimilation, are their own laboratories. This conforms to similar findings, which suggest a growing centralisation of R&D among leading high-technology companies. Furthermore, these companies place a significant emphasis on formal product plans that are market-driven and formal technology plans that are product-driven.

The Control Market Planning factor indicates the degree of researcher empowerment, researcher rewards, the integration of R&D with the business units and the level of R&D investment. It, therefore, signifies the propensity of a company to integrate R&D operations into product division operations and to manage R&D personnel based on R&D project success (Garnett & Pelser, 2007). The innovation management organisation (IMO) is responsible for developing new products and technologies in response to future threats and opportunities. Hence, science and technology from the external environment are combined with the company's in-house skills, knowledge and competencies to develop new products and technologies. Companies that have loaded high on this factor are displaying characteristics of a typical IMO. Furthermore, these companies commit high levels of investment to their R&D activities relative to sales and place emphasis on achieving financial leverage for R&D investments through external funding. These investments determine the technical outputs of a company, such as patents and new product and process technologies.

Another requirement of the innovation management organisation (IMO) is frequent new product introductions and frequent product upgrades, with the emphasis placed on expanding existing product lines and by introducing improved versions of existing products. The activities associated with this Product Development Intensity factor, are contained within the R&D, production and sales & marketing functions; the latter function being primarily responsible for interfacing between the company and the marketplace for introducing new or upgraded products.

The domain of innovation management includes both the R&D and strategic management functions. R&D consists of those activities and responsibilities ranging from understanding progressive technology to generating ideas to developing new products and technologies as underpinned by the R&D Commitment factor. Thus the collaboration between the R&D Commitment factor with the strategic management function activate the innovation process by identifying new and/or different combinations of market technology factors which will create the competitive advantage necessary for sustaining industry leadership.

Finally, this research indicates that technology policy plays a key role in the formulation and implementation of business strategies. It is thus recommended that companies use technology proactively as a competitive weapon and a key-positioning factor.

CONCLUSION

The rationale of this study was to investigate technology management in widespread use in technology intensive industries and to explore their relationship to company performance. The following two research questions were addressed in this study.

1. What is the prevalent technology management dimensions being employed by South African companies in technology intensive industries?
2. What relationships can be observed between the technology management dimensions and company performance?

Question one was addressed through factor analysing the technology management dimensions obtained from the survey. The second question was answered by regression analysis. The two distinct technology management factors obtained with the analysis were proved to positively influence the company performance dimensions and were classified as R&D Commitment and Control Market Planning factors.

Strategic management is inter alia a process of managing a company's relationship with the environment. As a matter of strategy, a product should be matched with that segment of the market in which it is in all probability most likely to succeed (Prinsloo, Groenewald & Pelser, 2014, p. 130). According to De Wet Fourie (2008, p. 34) managers can add value to organisational effectiveness and growth through the identification of new opportunities and the development of new markets in a global arena. A critical concern of this discipline is optimizing returns to the company's stakeholders over the long term. This means sustaining performance by balancing strategic investments in technology with short-term profitability.

The present study makes a significant contribution to the field of strategic management research by integrating the dimensions of several previous studies, to derive a more comprehensive taxonomy of technology management archetypes. It also derives a broader set of dimensions for use in strategic management research. The results show that technology management choices can significantly affect company performance. It thereby indicates which of the underlying dimensions have the strongest relationship with company performance.

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