Influence of Partners' Characteristics on the Effective Application of Technology Strategies: Case of a VTI

A. Sikander
School of Management and Governance, Murdoch University, Murdoch, Western Australia

Abstract--**Technology strategies have assumed an important role in providing technological leadership to firms. A study conducted by the author in the East, revealed that the performance of firms is influenced by the type of technology strategies adopted. This result provided the motivation to explore if such strategies are relevant to the management of the "services" sector and if their performance too is influenced by these adoptions. There is dearth of similar studies in the literature. More importantly, in this age of technology, there is a dire need for management to understand and implement appropriate technology strategies. The results could contribute to the literature/management in developing a set of strategies which could be termed as "global" and applied to any sector and those termed as "unique" which are specific to firm/service sector. In terms of the services sector, the nearest similarity to the technology intensive firms appear to be the vocational and technical institutions (VTI). The other justification to focus on technical institutions was that their performance is more affected by technology strategies/policies than the traditional primary and secondary schools/colleges. The big study sought to identify and analyse the level of awareness of participants on technology strategy issues and the perception of departments (including those in the Ministries) about technology management, gender, local/expatriate, qualification, teaching experience, years since last professional course completed, industry experience, understanding of quality, and department employed. This paper attempts to present the results on that part of the study which deals with the relationship between the type of the managers/management (gender, qualification, age etc) and the application of technology strategies.**

The participants included the staff and heads of departments at a technical college from an oil rich ASEAN country, the senior management at the college and the policy makers at the Department of Technical Education (DTE). The technology strategy (TS) and technology management (TM) data was desired from all the three groups. Data was collected through a questionnaire and analyzed using statistical techniques. A pilot-study helped to refine the questionnaire before it was administered. The study sets the tone to open up discussions and research interest towards applying strategic technology management tools in the education sector in a rapidly growing digital world. The type of managers/management revealed as part of this study has implications to the senior planners in the education sector in keeping pace with the technology age by providing valuable inputs to develop technology strategies/ policies.

I. INTRODUCTION

Technology Strategy is defined as the pattern of decisions, which sets technological goals and means for achieving these goals in relation to the business strategy and goals of the firm [1, p. 9]. Other researchers have also analysed this and focused mainly on the firm and that too in the manufacturing sector. We need to explore and understand if this definition is equally applicable to service organizations. There is a dire need to understand the role technology strategies play and the ways in which they are implemented in the technical education sector. Since VTIs are primarily service institutions, technology strategies must be embedded in their organization strategy. Due to rapid advances in modern technologies, VTIs, especially in developing countries, are assuming an important role. This realization has resulted in the establishment of new VTIs in both the government and private sectors and all are subject to intense competition, not only to secure more funds, but also to survive. A great contribution to the literature on technology management would be to highlight the types of technology strategies being applied in the VTIs and their similarities/differences with those in the manufacturing sector. This paper addresses that part of the big study which deals with the relationship between the type of the managers/management (gender, qualification, age etc) and the application of technology strategies.

II. LITERATURE REVIEW

The literature review focuses on the need for technology management. Since the application of technology strategies has traditionally been in the areas of business and manufacturing, it is necessary to explore and use them as a starting point for this research, which focuses mainly on the services sector.

The changing and dynamic nature of economies, place pressure on governments to be receptive to such changes and develop policies to adopt such changes. All sectors of the economy need to be developed to achieve a balanced growth. There is thus a need for institutions to remain abreast with the technological changes taking place in and around the region and adopt them to reap their maximum benefit. There are four different technology induction categories, which would enable the fulfilment of these aspirations [2, p.38]). These are:

1. Those technologies, which facilitate the achievement of goals in basic necessaries of food, housing, *education* and civic interaction.
2. Technologies which help in improving quality of life through the provision of health and medical facilities, clean and safe environment, *good education*, and improved means of transport and communication.
3. Those technologies, which enable significant improvements in standard of living through enhanced production, international competitiveness, and

employment creation (for matching a nation's supply and demand of labour)

4. Technologies of the new age; that is, new and emerging technologies which enable a nation to move upwards into the class of technological advanced nations (industrialized or high tech nations).

Fredrick [3, p.xv] defines technology as the "knowledge of the productive capabilities of a firm's business". Gillepsie and Mileti [4] used the term to refer to "types and patterns of activity, equipment and material, and knowledge or experience used to perform tasks". Dussage, Hart and Amanantsoa [5, p.13] further define technology as "the application of scientific knowledge to produce goods and services". These definitions of technology indicate that if technology can be applied to firms, it can also be applied to the services sector.

It can be expected that technology induction is equally applicable to the education sector (highlighted in italics above) and provides inspiration to conduct this study. The induction of technology would require a change in the structure of occupation of the work force. This could be met by implementing changes in the vocational and technical training so that the work force in this sector could face the challenges of the technology change. According to Omar [2], the old theories on favourable exchange rates, cheap labour, plentiful resources and government intervention would not completely be valid in the age of technological change. These theories need to be reconsidered in the light of these changes, which bring new ways of creating national wealth as well as generating some new limitations.

Closely related to technology is the issue of quality. Godfrey and Kolesar [6] defined quality as "how well a product or service performs its central function". This quality definition could be included in technology to provide a performance measure. It is thus apparent that technology and quality both relate to products and services. If they are applied to firms, they should equally apply to services.

According to Talonen and Hakkarainen [7], in an education environment it would be worthwhile to explore if there exists a technology-and-competence strategy. They suggest that the following questions need to be addressed:

- What are our pacing, key and base technological competences—now and in future?
- Which technologies will be replaced and which technologies should we use?
- What are the sources of our technologies and competences (also make-or-buy)?

Probert, Jones and Gregory [8] emphasize the need to exploit the critical technologies, else there is a probability of losing them out. This need should be equally applicable to the services sector (education in our case). Kashiwagi [9] has also highlighted the need for quality approaches to be adopted in educational institutions. It is also important to ensure that quality approaches should suit the environment [10]. Caution should be exercised to be aware of the downsides of implementing the practice [11, p.69]. Chester [12, p.57] states that "In higher education being strategic means being closely aligned with both the academic and business missions of the institution…Technology projects that don't support strategic goals have declining value for the institution". This definition gives meaning to strategic technology management application in the education sector. The entire staff and management in these educational institutions should play a role towards Strategic Management of Technology, a concept which is supported by Hugos and Stenzel [13] who suggest that if executives outside the technology department do not remain involved in important technology projects, either in an oversight or advisory role, it is likely that the project is misaligned.

According to Sahlman and Haapasalo [14], industry practitioners are facing enormous difficulties when attempting to formulate and integrate technology management activities with the company's strategy. The answers to these questions can provide us to determine the technology choice. This argument provides an opportunity for this research. Though it appears that this argument by the authors is inclined towards the manufacturing industries, it would be worthwhile to explore if there are responses to these questions in an educational environment which could help in determining if the sector has any technology strategy in place. Cetindamar and Ulusoy [15] informed about the 'influence' of partnerships towards innovation efforts in Turkish firms. This study seeks to extend this to the services sector (education) and explore on the 'characteristics' of each partner involved in the partnership: the staff, management and policy makers.

III. RESEARCH QUESTION

This study is part of a bigger study which explores several research questions and tests several hypotheses. The specific study seeks to answer the following research questions:

1. Which TS and TM factors are considered important by the managers in the education department?
2. Do different types of managers play a different role in the selection and implementation of appropriate technology strategies in a VTI?

Note: The managers/management include: the staff in the various departments of the technical college, the heads of departments at the college and the senior administrators of the college and the department of technical education.

IV. RESEARCH METHODS

The data for this study were obtained through a survey questionnaire which was developed for the bigger study undertaken by the author. This paper utilized only that part of the questionnaire which related to questions specific to this study. The survey questionnaire was pre-tested in a pilot

study to assess the clarity of its direction and the questionnaire items. The final questionnaire developed after the pilot study had three versions - one for the heads of departments, one for the instructors and one for the administrators at the college and at the department of technical education. The possibility of integrating the dimensions for these participants in the same questionnaire was considered but was dropped after conducting the interviews during the pilot study. The reason for having different versions was that corporate level issues are not presented to instructors who have normally not come across them and also policies developed at the Ministry level sometimes never reach the heads of departments.

The survey could have included all the teaching institutions, but only technical institutions were chosen because it was assumed, just as in the manufacturing sector, that technology-intensive institutions are more likely to have technology strategies and it is, therefore, easier to observe the relationships of interest. There are six vocational and technical institutions in this country. This study was restricted to the largest technical institution and to the department of technical education. Out of the 150 respondents surveyed, 10 were heads of departments, 103 were instructors and 37 were senior administrators at the college and at the Department of Technical Education.

Five types of data as used by Herman [16] were gathered for the study: individual's profile data, departmental profile data, technology data, operative environment data and technology policy (strategy and management) data. The data were gathered on five strategy and five management dimensions. Individual profile and department data were used to check for response bias and content validity. Technology data provided the existence of technology policies in the institution and the level of knowledge about technology of the respondents.

Technology Strategy(TS) Dimensions

1. Technology posture (firm's propensity to use technology proactively as a competitive weapon and a key-positioning factor).
2. Technology level (sophistication of the technology employed by the firm).
3. Product development intensity (number and rate of new product introductions).
4. Technology timing (firm's propensity to lead or follow competitors in introducing new products).
5. Manufacturing and process technology (degree to which new technology is incorporated into the firm's manufacturing plants and processes).

Technology Managemet (TM) Dimensions

1. Technology awareness (firm's scanning processes).
2. Technology acquisition (methods by which firms acquire technology).
3. Technology and product planning (formal planning processes that firms utilize to select and manage R&D programs).
4. R&D organization and management (methods firms employ to organize, empower and motivate research and development personnel).
5. R&D investment (methods by which firms fund R&D).

Based on the suggestions of executives at the Department of Technical Education, the instructors, heads of departments and administrators at the college were given the questionnaire by the principal of the college. The executives at the Department of Technical Education received theirs through their research and development officer. There was no need for follow-up letters, as the response was very encouraging.

V. HYPOTHESES

To investigate the various relationships between the factors of TS and TM dimensions and the demographics of the respondents the following hypotheses were proposed as part of this study.

H1: Technology Strategies (TS) in an educational setting is correlated to the demographic characteristics of the person.

H1a: There is a positive significant relationship between the TS factors and the gender of the individual.

H1b: There is a positive significant relationship between the TS factors and whether the individual is an expatriate/local.

H1c: There is a positive significant relationship between the TS factors and qualifications of the individual.

H1d: There is a positive significant relationship between the TS factors and industry experience of the individual.

H1e: There is a positive significant relationship between the TS factors and the duration since last professional course completed by the individual.

H1f: There is a positive significant relationship between the TS factors and teaching experience of the individual.

H1g: There is a positive significant relationship between the TS factors and the level of understanding of technology of the individual.

H1h: There is a positive significant relationship between the TS factors and the level of understanding of quality issues by the individual.

H1j: There is a positive significant relationship between the TS factors and the department the individual belongs to.

H2: Technology Management (TM) in an educational setting is correlated to the demographic characteristics of the person.

H2a: There is a positive significant relationship between the TM factors and the gender of the individual.

H2b: There is a positive significant relationship between the TM factors and whether the individual is an expatriate/local.

H2c: There is a positive significant relationship between the TM factors and qualifications of the individual.

H2d: There is a positive significant relationship between the TM factors and industry experience of the individual.

H2e: There is a positive significant relationship between the TM factors and the duration since last professional course completed by the individual.

H2f: There is a positive significant relationship between the TM factors and teaching experience of the individual.

H2g: There is a positive significant relationship between the TM factors and the level of understanding of technology of the individual.

H2h: There is a positive significant relationship between the TM factors and the level of understanding of quality issues by the individual.

H2j: There is a positive significant relationship between the TM factors and the department the individual belongs to.

VII. DATA ANALYSIS

The results showed that the majority of the instructors, heads of departments and the executives at the Department of Technical Education were quite senior in their specialist fields. The positions held by technical teachers start with Technical Assistant (TA) and move through Assistant Technical Instructor(ATI), Technical Instructor(TI), Senior Technical Instructor(STI), Education Officer(EO), Senior Education Officer(SEO), Assistant Director and finally Director. Amongst the staff who responded to the survey, the majority of them (67%) were either senior technical instructors or technical instructors. These two positions are achieved after at least five years service for locals and at least ten years for expatriates. The position of senior technical instructor in the case of expatriates is assigned to teachers having a Bachelor's Degree and around 15 years of experience. Of the nine heads of departments who participated in this study, six (67%) were senior technical instructors and the remaining three were education officers. At the Department of Technical Education, eight out of 25 (32%) were senior education officers and six out of 25 (24%) were education officers. This figures indicated a high senior level of experience.

Relationships between Background Variables and Extracted Factors

Factor analysis was used to transform the variables into a new set of linear combinations called the principal components.

The extraction using PCA for the technology strategy variables revealed that four components accounted for 71.3% of the total variance. The TS factors were named as: *program production and timing emphasis (TS1), technology dominance emphasis (TS2), program development intensity emphasis (TS3)* and *risk free unique program production emphasis (TS4).* The extraction using PCA for the technology management variables revealed that four components accounted for 83.2% of the total variance. The TM factors were named as: *R&D emphasis (TM1), technology awareness (TM2), market and technology planning (TM3)* and *foreign technology acquisition (TM4).* These results provide answer to research question No.1.

To seek answer to research question No.2, this section includes the analyses of relationships between the 'extracted factors' and background variables to test the various hypotheses posed earlier. There were a total of 32 items, 16 each for exploring the dimensions of technology strategy and technology management. Factor analysis revealed four factors each for TM and TS but in each case there was one significantly dominant factor. The dominant factor amongst the four TM factors was 'R&D Emphasis' having an eigen value of 6.49 whereas 'Program Production and Timing Emphasis' was the dominant factor amongst the TS factors having an eigen value of 7.29. The relationship between the background variables of gender, local/expatriate, qualification, industry experience, years last professional course completed, teaching experience, understanding of technology, understanding of quality and the department in which employed and each of the eight extracted factors is discussed in the following sections.

A one-way analysis of variance (ANOVA) was performed with each of the TS and TM factors as the dependent variables and the background variables as the independent variables. Since F-scores are uncorrelated because varimax rotation was employed, it is appropriate to use univariate analysis of variance. Significance between the factors and background variables was tested at p-values of 0.01 and 0.05. Homogeneity of Variance was tested using Levene's statistics at 0.05 test level. Taking the mean of relevant variables, which loaded heavily on the factor, developed the TM extracted factors. These extracted factors, which comprised the mean values, were treated as continuous variables.

The results show that there are two significant relationships between the background variable of department of the respondent with each of the two TS factors namely: TS factor 1(Program production and timing emphasis) and TS factor 3(Program development intensity emphasis) at 0.05 level of significance. This supports Hypothesis 1j. Levene's test for homogeneity of variances was not significant for each ANOVA analysis of these factors and the background variable, hence post-hoc analysis using Tukey HSD test was employed to locate the sources of the differences. There were many significant mean differences at the 0.05 level. For TS factor1, building, design and construction department had the highest group mean indicating that this department valued production of new, low cost and flexible programs at the right time The mean differences between the various departments on TS factor3 were not very significant, however, language and communication department scored the highest group

mean. It indicates that language department was inclined towards increasing the types of programs and improving them continuously. There was a significant relationship between the qualification of the individual and TS factor 1(Program production and timing emphasis) which supports Hypothesis 1c. Awareness of quality issues also showed significant relationship with TS Factor 4 (risk free unique program production emphasis) which supports Hypothesis 1h. Thus in relation to the posed main hypothesis H1, hypotheses 1c, 1j and 1h are supported. The significant relationships are summarized in Table 1 below:

TABLE 1:
ANOVA FOR TS EXTRACTED FACTORS (SIGNIFICANT RELATIONSHIPS)

Y	X	F value	Significance
TS Factor-1	Qualifications of the person	3.215	0.010
TS Factor-1	Department of person	2.352	0.017
TS Factor-3	Department of the person	2.149	0.029
TS Factor-4	Quality Awareness	2.429	0.025

The results show that there are three significant relationships between the background variable of department of the respondent with each of the three TM factors namely: TM factor1 (R&D emphasis), TM factor3 (Market and technology planning) and TM Factor 4(Foreign technology acquisition emphasis) at 0.01 level of significance. This supports Hypothesis 2j. Levene's test for homogeneity of variances was not significant for each ANOVA analysis of these factors and the background variable, hence post-hoc analysis using Tukey HSD test was employed to locate the sources of the differences. There were many significant mean differences at the 0.05 level, however, in all the three cases, the building, design and construction department had the highest group mean indicating that this department valued R&D, market and technology planning and foreign technology acquisition. Emphasis on three of the four TM factors, indicated the inclination of this department towards technology management. The relationship between TM4 (foreign technology acquisition) and whether the individual is an expatriate/local is found to be significant. This supports the Hypothesis 2b. Awareness of technology is also significantly related to TM4 (foreign technology acquisition) which supports Hypothesis 2g. Thus in relation to the posed main hypothesis H2, hypotheses 2b, 2g, and 2j are supported. The significant relationships are summarized in Table 2.

TABLE 2:
ANOVA FOR TM EXTRACTED FACTORS (SIGNIFICANT RELATIONSHIPS)

Y	X	F value	Significance
TM Factor-4	Local/expatriate	6.33	0.01
TM Factor-1	Department of the person	2.59	0.009
TM Factor-3	Department of the person	3.29	0.001
TM Factor-4	Department of the person	2.77	0.006
TM Factor-4	Technology awareness	2.52	0.02

VIII. PROPOSED METHODOLOGY FOR THE NEW STUDY

It is proposed to use the results of the study to develop a new questionnaire incorporating dimensions and items relevant to the East. This will provide a more meaningful outcome. The survey questionnaire like done previously, will be developed and tested in a pilot study.

The questionnaire will be tested in a pilot study and interviews before being finally administered. The background variables will be analysed after the data is entered in SPSS. The data from the main survey instrument would also be utilized to perform multiple regression analysis to observe the influence of the items on the elements and dimensions. It will also be used to predict the differences in responses to selected dependent and independent variables and predict the magnitude of elements and responses of the different firms. Factor analysis will be used to transform the variables into a new set of linear combinations called the principal components. The proposed conceptual model for STM would then be statistically tested using the PCA. A new model would be subsequently developed after naming the new factors at the item level. The new dimensions of TM and TS will also be used to determine the relationship with the educational institution size, institution type, R&D efforts and institution performance. The various hypotheses will be tested based on the above relationships.

IX. CONCLUSIONS

This study sought to seek answers to the two research questions 1) the type of TS and TM factors which the managers of educational institution apply as part of Strategic Technology Management and 2) their background characteristics which influence this application.

TS factors of *program production and timing emphasis, technology dominance emphasis, program development intensity emphasis* and *risk free unique program production emphasis and* TM factors of *R&D emphasis, technology awareness, market and technology planning* and *foreign technology acquisition* were found relevant to this study. The results also demonstrate that the background variable of department of the respondent showed significant relationship with the each of the two TS factors namely: TS factor 1(program production and timing emphasis) and TS factor 3(program development intensity emphasis). Qualifications and level of awareness of the managers also had significant relationships with TS factor 1 (program production and timing emphasis) and TS factor 4 (risk-free unique program production emphasis) respectively. The four TM extracted

factors; 'R&D emphasis', 'technology awareness', 'market and technology planning' and 'foreign technology acquisition' did not show any significant relationship with the background variables; 'gender', 'qualifications', 'teaching experience', 'years since last professional course completed', 'industry experience' and 'understanding of quality'. However, three significant relationships were seen to exist between the department in which the respondent was employed and the three TM extracted factors; 'R&D emphasis', 'market and technology planning' and 'foreign technology acquisition'. Why some departments are not interested in technology management? For example, the building, design and construction department were more inclined towards technology management compared to others. However, an extensive study is required to determine why other departments like business and management, hospitality and tourism and language and communication do not emphasize technology management. Is it that they do not employ hi-technology equipment or processes in the delivery of their programs, hence not interested in the management of technology? There was concern that even technology intensive departments like aircraft, electronics and computer scored low on technology management factors, which could to be explored in further studies.

X. CONTRIBUTIONS

The study has applied previous research in the area of strategic technology management in firms to technical education institutions. It was a beginning towards applying strategic management in the education sector and could be extended to the other services sectors. The study has implications for academics as the factors extracted and results obtained could be used to develop new instruments to be tested in the Eastern environment. It has implications for the Educational planners in terms of providing effective training to the staff and senior executives to be able to understand and apply effective technology strategies at their work places. Claver et al [17, p.56] support this view and indicate that staff needs to be trained and must be aware of the competitive advantage inherent in the technology adoption.

XI. LIMITATIONS OF THE STUDY

To keep this study manageable, the effects of technology policies on performance of the VTI were not explored. In determining the various factors affecting the management of technology, some exogenous variables like culture, financial structure and nature of courses offered were omitted. The study was also limited to one technical institution, albeit the biggest one, in terms of the courses offered and the number of staff employed. The study also used the items from prior research, which were evolved for manufacturing firms in a different cultural and technological environment.

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