

Development of an Organizational Knowledge Capabilities Assessment (OKCA) Method for Innovative Technology Enterprises

C.F. Cheung, Ricky Ma, W.Y. Wong, Y.L. Tse

Abstract—Knowledge capabilities are increasingly important for the innovative technology enterprises to enhance the business performance in terms of product competitiveness, innovation and sales. Recognition of the company capability by auditing allows them to further pursue advancement, strategic planning and hence gain competitive advantages. This paper attempts to develop an Organizations' Knowledge Capabilities Assessment (OKCA) method to assess the knowledge capabilities of technology companies. The OKCA is a questionnaire-based assessment tool which has been developed to uncover the impact of various knowledge capabilities on different organizational performance. The collected data is then analyzed to find out the crucial elements for different technological companies. Based on the results, innovative technology enterprises are able to recognize the direction for further improvement on business performance and future development plan. External environmental factors affecting organization performance can be found through the further analysis of some selected reference companies.

Keywords—Audit and Assessment, Innovation, Intellectual Capital, Knowledge and Technology Management, Knowledge Capability

I. INTRODUCTION

THE new era step into a knowledge-based economy, knowledge management (KM) is becoming a key factor for the organization success. Organization should no longer focus on the normal operation or physical resources solely, but they have to pay attention to the intangible and also valuable assets [1], [2]. Knowledge and Intellectual Capital (IC) are the valuable parts of intangible assets. Knowledge is the precious human capital and business opportunity to an organization. As a result, value can be added if companies are able to seize and good use of human capital though effective KM. Nowadays, technology plays a prime role to enhance the quality of life for mankind.

C.F. Cheung is with Knowledge Management and Innovation Research Centre, Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong (phone:852-27667905; e-mail: Benny.Cheung@inet.polyu.edu.hk).

Ricky Ma is with the Hong Kong Sciences and Technology Parks (e-mail: ricky.ma@hkstp.org).

W.Y. Wong is with the Knowledge Management and Innovation Research Centre, Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong (e-mail: 06052615D@polyu.edu.hk).

Y.L. Tse was with Knowledge Management and Innovation Research Centre, Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong (e-mail: winnietyl@gmail.com).

Companies kept their traditional way of management would no longer be able to provide a competitive environment for knowledge work so as to sustain their competitive advantages in the industry [3].

In the past, competitiveness relies heavily on how companies manage their physical assets [4] and they are focused more on maximizing the value added through optimizing production process, increasing production efficiency and improving the quality of products. However, the value creation in knowledge economy focuses more on the innovation process and the intangible assets. Many organizations lack the ideas about managing knowledge, so they overlook the value of leveraging the operation and revenue potential from their intangibles and intellectual assets [5]. Furthermore, the ignorance of the relationship between IC and innovation may hamper the companies. This is particularly true for innovative technology enterprises which rely heavily on their innovation performance in order to gain competitiveness. The innocence and low awareness of IC or related management may adversely affect the prospects of the enterprises as well as their technology development.

Currently, there is a lack of common and standardized methodologies for the assessment of the knowledge capability of an enterprise. The traditional audit methods are found not to be comprehensive enough since most of them focus on assessing the firm's intangible capitals or only reflecting the total company performance. There is a lack of interrelation between IC and innovation which is found from the audit. As a result, a tool for auditing and assessing knowledge capability and Intellectual Capital is much needed, especially for innovative technology enterprises.

In this paper, a knowledge capability audit and assessment tool named Organizational Knowledge Capabilities Assessment (OKCA) is purposely designed and developed. The OKCA not only attempts to determine the relationship between knowledge capabilities and organizational performance but also the strengths and weaknesses of organization in terms of their KM applications. Hence, it can uncover the knowledge capabilities and various performances of different technology enterprises from different industries. In the OKCA method, questionnaires were designed and distributed to the target enterprises being investigated. Follow-up face-to-face interviews were conducted to clarify the results and increase the reliability of the developed OKCA method.

The statistical analysis methods such as T-test and regression analysis are used to determine the critical factors affecting knowledge capability and relationship between organization performances. Some interesting observations are found. The analyzed results can help technology enterprises to identify their knowledge capabilities and realize their strengths and weaknesses in IC and innovation management.

II. LITERATURE REVIEW

A. Knowledge Management (KM) and Knowledge Capability

In knowledge economy, knowledge becomes more critical elements and is regarded as the raw resources in most enterprises. It is the most significant and essential resources in the value creation process in an enterprise [6], [7]. There is a close relationship between knowledge and value creation. KM is not only a formal and structured initiative to improve the creation, distribution, or use of knowledge but is also a formal process of turning corporate knowledge into corporate value in an enterprise [8].

In the past century, companies are equipped with the financial techniques for managing personnel and assets so as to measure the business performance. However, the business environment has shifted. The traditional measurement methodology is no longer adequate to assess the intangible assets and obtain the future value of an enterprise. Knowledge, competence, and related intangibles have emerged as the key drivers of the competitive advantage in the rival market [9], [10]. Hence, it needs a change of measurement tools and new management strategy. Moreover, the changes are fluctuating in terms of consumers' needs and taste, technology, market structure and competitors. New knowledge is a crucial element to maintain and extend the market for companies to integrate new knowledge and meet varying needs [11], [12]. KM is highly related to intellectual capital of firms which influences its financial achievement [13]. Hence, financial benefit could be achieved through well management of knowledge assets and intellectual capital in an organization.

According to Dawson [14], organizations would utilize their resources, intellectual capital and input of information by performing knowledge process. Knowledge capabilities refer to the effectiveness in performing these knowledge processes so as to achieve sustain competitive advantage [15]. In technology enterprises, knowledge capabilities could be regarded as the critical success factors of the enterprise's business performance, as well as their innovation performance.

Various studies have stated some factors affecting the knowledge capability of an enterprise and as follows:

1) External Environment – As the volatile nature of external environment, knowledge process would be affected. The changing market and competitive environment would alter the KM strategy. As mentioned by Jones and Dawson [16], the main knowledge capabilities are scanning, sensemaking and pattern recognition in organization's environment which. The external environment such as the policy, promotion and infrastructure, would significantly influence

the efficiency and effectiveness of knowledge processes.

- 2) Structure of Organization – Structure of organization is one of components of knowledge capabilities. It can be considered as the internal environment affecting the knowledge process. The complexity of creating, sharing and using knowledge relies on organizational structure [17]. The company structure has significant impact on interaction and cooperation among individual and thus the knowledge processes such as knowledge creation and knowledge transfer. The effectiveness of knowledge processes would turn out to be the crucial elements of business performance.
- 3) Organizational Culture – Organizational culture is also relative to the internal environment. Nikolaj [17] stated that organizational culture could support collaboration and motivate knowledge sharing among employees. Hence, an enterprise builds up a united goal to implement knowledge process which put the enterprise in an advantageous position. Besides, learning affects innovation [18], [19]. The cultural factors such as decentralization, error tolerance or social relations showed the influence on the outcome of managing knowledge and innovation through organizational learning.
- 4) Knowledge Process – Knowledge processes deal with knowledge through knowledge generation, knowledge storing, knowledge transfer, and knowledge retention. Knowledge generation is closely related to innovation as the efficiency and effectiveness of innovation could be improved by continual organizational learning [20]. This is particularly true for high tech industry. The new product development is frequent in order to enhance the competitiveness [21]. Knowledge conversion capability and knowledge application are the critical components to assess the effectiveness of knowledge processes. This is due to the fact that knowledge could not promote innovation if it is unable to be transferred and distributed [22].
- 5) Knowledge Protection Capability and Technology Capability – For innovative technology enterprises, knowledge protection is highly emphasized. Intellectual Property (IP) is greatly favorable to those enterprises since IP provides the legal protection so to optimize the value created from innovation [23]. As a result, it can secure strong competitive positions and create revenues through the protection of the intangible assets. Technology capability is mainly concerned with the enterprise's effort on technology development, which is the core business and objectives of innovative technology enterprises. Hence, it is one of the key indicators to determine the success of the innovative technology enterprise and its effectiveness of the business process.
- 6) Marketing Capability – Marketing capability is regarded as one of the knowledge capabilities that have impact on business performance. A source of competitive advantages should not merely rely on technology, but marketing

capability [24]. Effective marketing strategies allow enterprises to gain the reputation and image which is the intangible asset affecting their business. Besides, recognition of market environment would provide useful information (knowledge of marketing) for company to make the informed decision on the implementation of the marketing plan. Hence, marketing issues may also influence the sales growth which is crucial to the existence of an enterprise.

Based on the above factors, it can find out that the critical factors of organization performance in term of knowledge capability and KM. Besides, dozens of academic journals stress the close relationship between KM, intellectual capital (IC) and innovation. One of the reasons of KM is to accelerate the development of new or significantly improved products or processes as part of its commercial activities. This is innovation [25] and the outcome is also treated as IC assets. An effective KM would favor innovation and IC assets by well monitoring the knowledge process.

B. Intellectual Capital (IC)

Nowadays, Intellectual Capital (IC) is mostly coherent to KM which plays an important role for knowledge society. IC is commonly interpreted as the intangible and knowledge based asset that cannot be typically reported in the traditional accounting system. In the new era, the importance of IC for organizations may even greater than that of traditional tangible assets. The evidence could be found in the Brookings research institute: 62% of a company's value was embedded in its physical capital in 1962 and by 1992 that figure had decreased to 38% and there is a trend of continuous decline [26].

IC is basically classified as Human Capital, Structural Capital and Relational Capital respectively. Human capital refers to the resources that people possess of such as value, knowledge, competence, attitude and even the ability to generate know-how [27]. Structural capital consists of physical and non-physical assets which belong to the organization include organizational and technological elements. Relational capital includes the organizational resources related to the external agents such as relationship with customers and other stakeholders. Hence, different IC represents different types of intangible resources and capabilities. The firm may make an informed decision about the priority of monitoring those valuable intangible assets.

IC management aims to enhance the organization's value creation and value extraction capabilities at strategic level [28]. Lönnqvist and Kujansivu [29] emphasized the control and development of IC factors in business. The controlling activities consist of identifying, measuring and directing IC while the development of IC focuses on actions carried out in practice. Hence, the core tasks of IC management focuses on identifying, measuring, controlling and developing the intangible resources of business. As shown in Fig. 1, the Skandia IC model acts as the foundation for enterprises to develop a specific system to value and manage IC [30] which can create the sustainable market value.

In the past, those traditional financial and management accounting instruments tend report a company's financial assets and, they can only reflect the past performance but not the future growth potential of an enterprise. Moreover, the value of an enterprise should not just be confined in financial term. The incomprehensive financial reporting mainly concentrates on the physical aspects of a company, but the non-physical sources are usually overlooked. The demand of IC reporting is blooming.

There is an increasing number of IC audit measurement approaches are emerging among knowledge-based enterprises. On the other hand, the IC disclosure on corporate side raises the awareness in the financial community as well. According to Rau [31], the President of European Federation of Financial Analysis Society (EFFAS), more and more national members are spending effort on developing the reporting model on intellectual assets which find it effective to uncover the value drivers of organization. Hence, it showed that the IC assessment is going to complement the traditional accounting technique in the new knowledge economy in the near future.

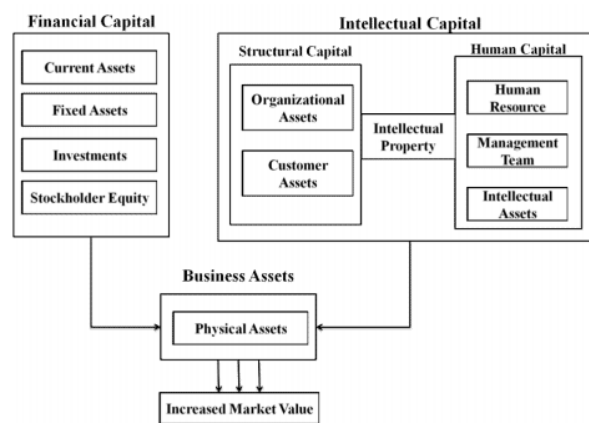


Fig. 1 Skandia IC model (Adapted from Edvinsson and Malone, [30])

The reason of IC management is generating values by utilizing the intangible resources of an enterprise. Hence, IC audit is indispensable to determine and recognize how IC assets contribute to value creation in a company. IC audit is a tool for enterprise to manage and control performance since it may help to track and trace the records and strategy execution which provide the room for improvement [32]. Hence, IC audit can be a tool for estimating the firm's future growth potential. The higher level of disclosure on IC allows the enterprises to make better decision on strategic planning. Moreover, the enterprises can communicate more effectively with external stakeholders through IC audit. Enterprises would manage and integrate the relationships and interests of shareholders, in order to satisfy them willing to have a stake in the business. It can ensure the long-term success of the organization. Hence, IC audit can also be used to enhance the visibility of a company's business plan that may help the investor to gain the insight of a firm's prospects and risk profile.

C. Innovation in Technology Enterprises

Innovation is a process that transforms new know-how into something of value [33]. Innovation enables an enterprise to adapt to the changing business world. In the old economy,

production process is the core. Once enterprises understand the customers' need, they would focus on production optimization by shortening the production time and improving the product quality. The value creation emphasizes more on the enterprise's industrial capability and capital budget which are the tangible and financial assets. However, the world is changing and everything around is improving for knowledge economy. Keep going on the production optimization is not the only value-added process. Hence, by adopting innovation as the core business process may be the way to generate additional value adds.

Nowadays, the increasing technological awareness creates more needs for enterprises to satisfy and so called "knowledge thirsty customers" [34]. Their demands change rapidly and are unexpected. By generating something new from innovation, an enterprise can secure existing customers and expand new market. Most studies indicated that innovation generates positive effect and enhances the competitiveness of enterprises [35], [36]. Hence, competitive advantage is another factor pushing innovation to bring business to stagnate and companies to go out of business.

Innovation is the process to transform organizational knowledge into products or a working process [34], [37]. The outcome of innovation would be new and tangible product or service. It is obvious that innovation generation involves knowledge process. The model from Elia and David [37] shows the innovation process from dynamic capabilities to innovation which is expressed by new products or service. Dynamic capabilities refer to an organization's stable knowledge pool or the IC of company. Also, innovation creation emphasizes on modification and change of routines which is proven its importance by Leonard Barton [38] saying that routinization may constrain the continual development of routines and thus the innovation creation.

In knowledge economy, brainwork by employees is used to evoking and innovating new application. The emergence of knowledge-intensive products would further bring about an increasing demand for knowledge. The growing demand of customer requirements may bring the knowledge intensity of business processes. Knowledge would get cycled through the innovation process to produce innovate products, which in turn enlarge the knowledge pool that again supply to the production process. Hence, it becomes a cycle of knowledge and innovation as shown in Fig. 2 [34]. The cycle of innovation also infers vital elements of innovation performance including marketing capability and knowledge process.

As a whole, intellectual capital (IC) and innovation are the critical factors affecting the knowledge capability of organization as shown in Fig. 3. Innovation requires the build-up and access of knowledge. When knowledge is managed and processed in an efficient and effective manner, innovation is brought as advantageous to organizations. Intellectual capital is more unique and embedded in employees' brain. As a result, a good IC management reflects a higher knowledge capability of a company. The demand of IC auditing and reporting tools is growing.

However, the existing tools are inadequacy and ineffectiveness to demonstrate the cause and effect relationships between intangible assets and organization performance. As a result, a feasible assessment tool has to be developed for innovative technology enterprises. The assessment tool attempts to find out the linkage between knowledge capabilities and organizational performance. This allows enterprises to recognize the existing intangible assets and uncover the strengths and weaknesses in managing knowledge in the enterprises. Moreover, the audit and assessment results are provided for the stakeholders to have better an understanding of the enterprise' prospect and risk profile which may help for the decision making.

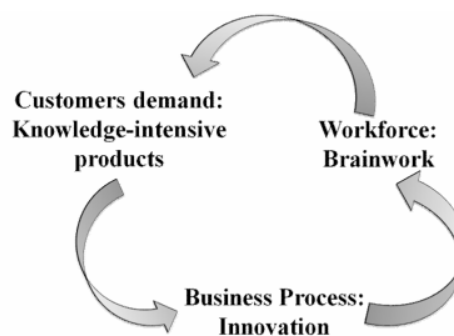


Fig. 2 Cycle of knowledge and innovation (Adapted from: Nermien, [34])



Fig. 3 Relationships between innovation, intellectual capital and knowledge capability

III. ORGANIZATIONAL KNOWLEDGE CAPABILITIES ASSESSMENT (OKCA) METHOD

In order to find out the relationship between knowledge capabilities and organizational performance and the critical success factors for technology industries, a knowledge capability audit tool called Organizations' Knowledge Capabilities Assessment (OKCA) is built. OKCA is a questionnaire-based assessment tool which is divided into three parts as shown in Fig. 4. A sample survey questionnaire for OKCA is shown in Appendix.

Part A of the OKCA is demographics which focus on basic information relative to the company and the respondent itself such as company's size, technology cluster or the working

experience of the respondents. This part is mainly used to determine the categories and natures of interviewees. Part B is the Knowledge and Innovation Capabilities, which aims at studying the firm's awareness of Knowledge and Intellectual Capital (IC) management. This is the core body of the assessment. It includes nine subsections which are Knowledge City Capability, Structural Capability, Cultural Capability, Learning Capability, Knowledge Conversion Capability, Knowledge Application Capability, Knowledge Protection Capability, Technology Capability and Marketing Capability

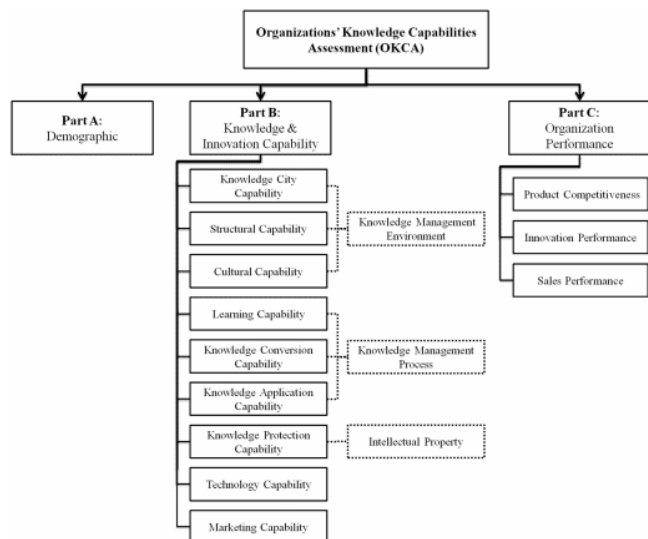


Fig. 4 Framework of organizational knowledge capabilities assessment (OKCA) method

Knowledge City Capability is talking about the crucial elements of geographic region influencing the operation and implementation of KM of company. The questions mainly focus on the government's policy, provided facilities, any support contributing to application of Knowledge Management. Structural Capability is a firm's ability to facilitate the implementation of KM. It refers to the corporate structure affecting the relevant KM process. Cultural Capability refers to the firm's ability in securing organizational mechanism and harmony, cultivating the organization culture that facilitates KM. All these three capabilities are the external environment factors influencing the management of intangible assets and can be classified as "Knowledge Management Environment".

Learning Capability is a firm's ability to generate new knowledge or acquire knowledge from other parties. Knowledge Conversion Capability refers to the firm's ability to identify and assimilate knowledge which is then shared and transferred throughout the organization. This is critical to the firm's organizing skills on knowledge like whether they can integrate the knowledge sources and coping with the outdated knowledge. Knowledge Application Capability is the firm's ability to make good use the knowledge improve the internal operation or enhance the competitiveness. These three capabilities belong to the management process that how the firm copes with the intangible resources to maximize the knowledge value and grouped as "Knowledge Management Process".

Knowledge Protection Capability refers to the attitude and measures to protect knowledge and Intellectual Property (IP). Technology Capability refers to all the intangible assets related to technology development or the company's effort put on the technology management. Marketing Capability is the ability to maintain the competitive advantages on the market and the actions to explore new markets, as well as expanding the market shares. Hence, this part can assess the internal and external environment of company based on the five major factors of Knowledge and Innovation Capabilities.

The last section of OKCA is Organization Performance, which focuses on the status of the organizations in terms of their performance gained from their effort on business process. Business details consisting of Product Competitiveness, Innovation Performance and Sales Performance are audited. Product performance is the indicators reflecting a firm's market advantage and competitiveness of the product or service that lead the firm to success. Indeed, it is believed that the knowledge capability would greatly affect the competitive advantages of product or service, so the higher competitiveness the better knowledge capability.

Innovation performance is measured regarding the effort a firm put on developing advanced technology or new products. Innovation rate is measured instead of the number of innovations alone since the number on innovation across the industry varies that make the comparison difficult. The high-performance firms in terms of product performance have stronger capabilities compared to low performance firms. Sales performance is the dimension covering the financial performance of firms. It is measured in terms of the average annual sales growth rate over the last three years. Sales growth may reflect the market advantages of the firm and the relationship between knowledge capability and sales performance.

Since the OKCA method is based on a questionnaire based assessment, a list of questions and statements are provided to interviewees. Seven-point Likert response scale is used on Part B (Knowledge and Innovation Capabilities) and Product Competitiveness of Part C. 1 represents strongly disagree and 7 represents strongly agree of the statements. Innovation Performance and Sales Performance are measured by means of nine-point scale. Table I shows the question distribution and total score of Part B.

After collect all the questionnaires of OKCA, scores comparison of knowledge capability, t-test and regression analysis are done through Microsoft Excel and Statistical Package for the Social Sciences (SPSS). Some graphs are drawn to clearly indicate the trend and pattern of data. Scores comparison is only performed on Knowledge and Innovation Capability part. The total score distribution of each company is compared in order to capture companies with the best and the worst performance in the industry. Then, score distribution of each companies in specific knowledge capability is compared that help to find out the good and poor performer in particular areas.

TABLE I

TOTAL SCORE OF PART B (KNOWLEDGE AND INNOVATION CAPABILITIES)		
Knowledge and Innovation Capabilities	No. of questions	Score
Knowledge Management Environment	19	133
Knowledge Process	17	119
Intellectual Property	3	21
Technology Capability	8	56
Marketing Capability	7	49
Total	54	378

The comparison within and among different technology clusters or industries is also done, so performance of each company in each clusters or industries can be easier known.

An analysis based on T-test is done to find out the impact of company's performance on the rating of knowledge capabilities. The responding companies will be classified into high performance company and low performance company based on the score of performance indicators (Table II). Then, T-test is used to examine whether the difference between those two groups is significant or not. The company's performance would affect the level of knowledge capabilities when there are significant differences between the two groups. Regression analysis is conducted to find out the correlation between various knowledge capabilities and different performance indicators. In this analysis, the five areas of knowledge capabilities (Part B) are independent variables while the three performances indicators (Part C) are dependent variables. Hence, the effect of knowledge capabilities on performance indicators can be reflected through the correlation between factors of Knowledge Capabilities and three performances indicators

Interview may be conducted after analyzing all the data, so the result can be testified. A face-to-face interview can help to collect more meaningful data from the company directly. Extra information could be gained to prove the accuracy of the result and is a way to testify the assessment method and result. Suggestions are given to the assessed companies so that they can get the ideas how to manage their Intellectual capital (IC). Also, companies can identify their knowledge capabilities and realize their strengths and weaknesses in IC management. The amendments could then be made for encouraging their further growth and development.

TABLE II
CRITERIA OF COMPANY GROUPING FOR T-TEST

Performance Indicators	Criteria	Performance Indicators
Product performance	Strong firms: Average product competitiveness score ≥ 6 marks Weak firms: Average product competitiveness score < 6 marks	Product performance
Innovation performance	Innovative firms: Average innovation rate $> 30\%$ Traditional firms: Average innovation rate $< 30\%$	Innovation performance
Sales performance	Growing firms: Average sales growth rate $> 20\%$ Steady firms: Average sales growth rate $< 20\%$	Sales performance

IV. TRIAL IMPLEMENTATION OF ORGANIZATIONAL KNOWLEDGE CAPABILITIES ASSESSMENT (OKCA), RESULTS AND DISCUSSION

The OKCA method has been trial implemented in 19 innovative technology enterprises of various sizes from different technology clusters. As shown in Fig. 5, they include enterprises from Electronics and IT/Telecommunication, Precision Engineering and Professional Services.

Percentage of Respondents Clusters

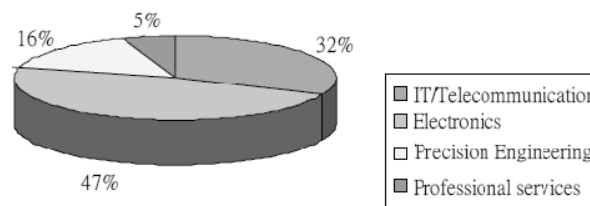


Fig. 5 Background of innovative technology enterprises engaged in trial implementation of the OKCA method

A. Score Comparison

After collecting all the data from 19 companies, the scores of Knowledge and Innovation Capability (Part B) are compared. The best and worst performers are defined in each knowledge capabilities, so the best practices in each area can be defined. The total average scores of Knowledge and Innovation Capability is 281. More than 50% of respondents obtained above-average score in Intellectual Property, Marketing Capability and Technology Capability while fewer respondents obtained above-average score in 50% in Knowledge Management Environment and Processes. On the view of five knowledge capabilities as shown in Fig. 6, all companies got the higher score in Technology Capability while the score in KM Environment is the lowest.

Score Comparison of Five Knowledge Capabilities

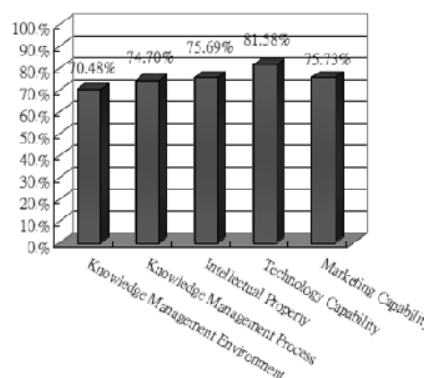


Fig. 6 Score comparison of five knowledge capabilities (Part B)

By comparing the knowledge capability performance of each technology cluster (Fig. 7), Precision Engineering cluster obtained the highest scores while Electronics cluster obtained the lowest scores. Precision Engineering industry requires lots of technical know-how and effort put on researches.

As a result, it got the highest score in technology capability. Marketing capability is also quite well given that Precision Engineering appears to be new technology as compared with others and thus more marketing effort should be put to raise public's perception about it. On the other hand, Electronics clusters also got high score in technology capability because this industry involves a vast of technical knowledge which is closely related to technology capability. However, the overall performance shows an inferior performance in intellectual property (IP). It could be explained that more small and new companies put less attention on IP causing the lower overall score in this area. For the IT/Telecommunication cluster, IP is commonly more important than other knowledge capability. Indeed, the rights of elements in IT/Telecommunications industry are specially needed to be protected such as software, system and transition infrastructure.

There are regarding legislation which shows the close relationship between IP and IT/Telecom.

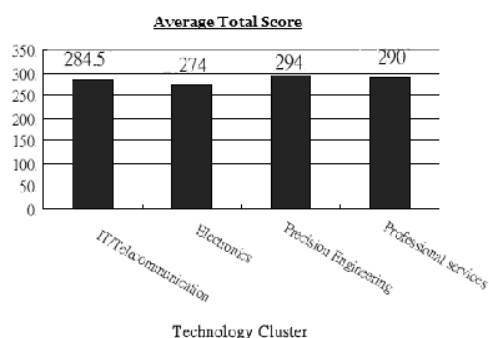


Fig. 7 Average total score of technology clusters (Part B)

When comparing the overall total score of all companies and the score of all companies within each knowledge capability, some findings can be concluded. It is found that the innovative technology enterprises are strong at technology capability. The result is expected since they always emphasize on technology area and desire to create something new by innovation. They aim at pursuing the new edge in technology and thus got high score in technology capability. However, no more than half of the respondents got the above average score in intellectual property. This may reflect that they are ineffective to manage their intellectual property protection and intellectual capital management. Besides, it can find that resource is a critical factor for developing knowledge capability from the result of best performer. Precision Engineering cluster is found as the best performer among the technology clusters. It is because these companies are capable to acquire external research funding which provides more resources to enable them to put effort on developing and managing their intellectual capital and knowledge capabilities. Hence, more resource, better the knowledge capability will be.

B. T-test and Regression Analysis

Server statistics analyses have been done on all collected data, in order to find out the critical factor affecting the knowledge capabilities and relationship of organization

performance. From the descriptive statistics analysis, technology capability is scored the highest marks of mean score (5.75 marks). It is recognized that technology is the primary focus of lots of companies in high tech industry. Then, referring to organizational performance, Innovation performance is the best for the firms. This reflects that innovation may be the part companies emphasize the most.

T-test is done to classify the companies into strong and weak performers. For the product competitiveness, 74% of respondents are the strong firms and 26% are the weak. The analysis result shows that the strong companies regarding product competitiveness possesses higher knowledge capability scores than the weak firms in all the five dimensions. For the Innovation Performance, 79% of firms are treated as the innovative technology enterprises while other 21% are conservative firms. The innovative technology enterprises have higher scores in knowledge capability components than the conservative firms in all aspects except intellectual property and marketing capability. This is a special finding that can be further expounded. For the Sales Performance, 53% of respondents are defined as growing firms and the 47% of firms are steady firms. As expected, it is found that growing companies have higher knowledge capability scores than steady firms in all the five knowledge capabilities.

In the three t-tests result as shown in Table III, all the t-values are not between 0 and 0.05, meaning that there is no significant difference between the high performance company and the low performance company. It can be concluded that the knowledge capability is not affected by the level of performance. The high performance company would not necessarily gain better knowledge capability or vice versa. However, there is a special finding in the t-test result of innovation performance. It is interesting to note that the mean score of the conservative companies is larger than that of innovative technology enterprises. Indeed, it can be expounded by the impact of the company size. In the present study, half of the conservative companies are large enterprises. Meanwhile, the result showed that the conservative group has better knowledge capability in terms of IP and marketing. Abundant assets allow these large enterprises to simultaneously focus on diverse areas including patent issues and strategic marketing. As a result, it can be concluded that knowledge capability would be influenced by the company size. It is also proven that resources are crucial to develop the knowledge capabilities, both physical and intangible.

TABLE III
 RESULT OF T-TEST ANALYSIS

		Product Competitiveness	Innovation Performance
Knowledge Environment	Management	2.279	0.954
Knowledge Management Process		1.079	0.561
Intellectual Property		1.288	0.880
Technology Capability		1.568	0.352
Marketing Capability		0.466	-2.294

*Significant at the 5% level

In addition, the impacts of individual knowledge capability on the product competitiveness are examined via regression analysis and the standard regression coefficients of the variables are computed as shown in Table IV:

TABLE IV
 STANDARD REGRESSION COEFFICIENT WITH KNOWLEDGE CAPABILITIES

		Product Competitiveness	Innovation Performance
Knowledge Environment	Management	No	No
Knowledge Process	Management	0.054*	No
Intellectual Property		No	0.029*
Technology Capability		0.166*	No
Marketing Capability		No	0.020*

* P < 0.05

In this regression model, the found value shows that the capabilities in Knowledge Management Process dimension and Technology Capability significantly affect the product competitiveness. Product competitiveness mostly depends on the attractive product attribute and its functionality. For technological products, it is more critical on its novelty. The R&D is thus the most crucial factors influencing the product performance. With good learning capability the organization, enterprises are able to generate ideas across multiple boundaries and learn the lessons of past experience. As Senge [39] mentioned, the capacity to sustain innovation has been associated with organization learning. Then, even the firms acquired useful know-how, how they are to convert and apply the know-how in the right way is critical. With effective knowledge creation, conversion and application of knowledge, companies could innovate their products which gain the competitive advantages. On the other hand, high technology capability may refer to well performing practices on R&D activities which is also the contributors to enhance product competitiveness. Hence, Intellectual Property and Marketing Capability determine the innovation rate of enterprises. It reveals the true facts that protecting organizational knowledge and well marketing strategy is crucial to successful innovation. Elias and Piero [40] also defined a theory of "the four knowledge bases of product innovation", which emphasizes on the significance of end-user knowledge base, brand knowledge base and business logic knowledge based on product innovation. It aligns the result that marketing capability has great influence on innovation rate of product/service. Besides, some creative ideas may be easily copied by other parties if there is a lack of knowledge protection. Here, IP say patents and copyright may protect the new ideas from being used so that the innovative concepts could be kept developed and turned into the innovative physical products.

Finally, the impact of Knowledge Management Environment and Marketing Capability is significant on the sales growth rate of organizations. This study verifies that a firm's sales growth is primarily influenced by both internal and external environment.

Generally, sales growth rate could reflect the return on investment (ROI) in financial terms. For companies in technology industry, most of their investment is spent in

technology development, technological researches and experiments. However, this kind of investment and the return is rarely proportional because their deliverables are unlikely to be the common expendable. The high tech products always need time to be accepted, testified and spread on the market due to its innovative nature. Hence, the impact of technology capability on sales growth is not really significant. Nevertheless, marketing capability becomes the critical success factor to push the sales. Innovative products most likely target on specific segments of customers. Hence, whether the enterprises can succeed depend on the fulfillment of customers' needs. It is vital for the enterprises to build a good relationship with the customers and to establish a good brand image. Furthermore, better Knowledge Management Environment may smooth the operation that favors the attainment of the organization's goal to making profit from the growth of sales.

To summarize the three relationships, it is found that knowledge capabilities are critical to the enhancement of specific performance. Hence, the relationships between knowledge capability and organization performances are found. The result may be used by companies for reference to know their focus which they want to improve themselves. In the models, marketing capability affects the innovation performance and sales growth of organizational performance. Hence, marketing capability is vital factors to innovative technology enterprises. Better marketing strategies may help the companies differentiate them from others since the extra competitive advantages are created.

V. CONCLUSION

Despite a lot of previous research work highlights the important role of knowledge capabilities on the organizational performance, there is still a lack of appropriate assessment tool with empirical findings to uncover their interrelationship. Given that Intellectual Capital Management (ICM) is increasingly essential affecting the performance of technology enterprises. This paper presents an Organizational Knowledge Capability Assessment (OKCA) method to investigate the interrelationship between knowledge capabilities and organizational business performance. The knowledge capability audit and assessment tool was successfully applied in a number of innovative technology enterprises in Hong Kong.

From the result analysis, most companies being studied spend a large proportion of resources on technology development aiming at establishing the competitive advantage. Only few enterprises would put more effort to develop other capabilities such as marketing and knowledge processes due to the abundant capitals. The results also show that there exists a significant correlation between knowledge capabilities and organizational performance of the companies. All the five categories of knowledge capability contribute to various areas of business performance.

Knowledge management process and technology capability are the most important to product competitiveness while marketing capability and Intellectual Property (IP) plays a pivotal role in enhancing the innovation rate. Knowledge management environment and marketing capability are essential elements to spur the sales growth.

On the whole, The results of the study provide some useful and empirical evidence as well as insights of current knowledge capabilities for innovative technology enterprises. The OKCA method is found to be helpful to find out the strengths and weaknesses of innovative technology enterprises so that improvement can be made for further developing the innovation. Companies are able to get ideas of which area they should focus on and the direction for strategic planning. This is beneficial for their business growth and development, and raise and sustain the enterprise's competitive advantages. As a result, the knowledge capability assessment and audit is valuable to be applied in the technology industry.

ACKNOWLEDGEMENT

C.F. Cheung would like to express their sincere thanks to the Research Committee of The Hong Kong Polytechnic University for financial support of the research work under the project no. G-U999.

REFERENCES

- [1] B. Lev, and J. H. Daum, "Intangible assets and the need for a holistic and more future oriented approach to enterprise management and corporate reporting," *The First PMA Intellectual Capital Research Symposium*, Cranfield, UK, 1-2 October 2003.
- [2] C. I. Fadur, and D. Ciotina, "Is the future of accounting compatible with the accounting of the future?," *CES Working Papers*, Centre for European Studies, Alexandru Ioan Cuza University, vol. 3, 2011, pp. 55-63.
- [3] J. W. M. Kessels, *The Knowledge Revolution and The Knowledge Economy, The Challenge for HRD*. In J. Woodall, M. Lee, & J. Stewart (Eds.), New Frontiers in HRD, London: Routledge, 2004.
- [4] S. Guo, C. Wang, and X. Luo, *A Study on Knowledge Management in Enterprise Information Systems*, International Federation for Information Processing, vol. 205, A. M. Tjoa, L. Xu, S. Chaudhry, Eds., Research and Practical Issues of Enterprise Information Systems, Springer, Boston, 2006, pp. 597-608.
- [5] M. Tayles, N. Adshead, A. Bramley, and J. Farr, "Dealing with the management of intellectual capital: the potential role of strategic management accounting," *Accounting, Auditing and Accountability Journal*, vol. 15, no. 2, 2002, pp. 251-267.
- [6] T. A. Stewart, *Intellectual Capital: The New Wealth of the Organizations*, New York, USA: Doubleday/Currency, 1997.
- [7] P. Drucker, *Post-Capitalist Society*, New York, USA: Harper Business, 1993.
- [8] T. H. Davenport, and L. Prusak, *Working Knowledge, How Organizations Manage What They Know*, McGraw-Hill, 1998.
- [9] D. J. Teece, *Managing Intellectual Capital*, New York, USA: Oxford University Press Inc, 1998.
- [10] M. C. Gregorio, E. N. L. José, L. S. Pedro, and A. S. Elsa, "Organizational capital as competitive advantage of the firm," *Journal of Intellectual Capital*, vol.7, no.3, 2006, pp. 324-337.
- [11] L. A. M. John, and D. Foray, *Knowledge Management in Innovation Process*, Massachusetts, USA: Kluwer Academic Publisher, 2001.
- [12] T. Housel, and A. H. Bell, *Measuring and Managing Knowledge*, New York, USA: McGraw Hill, 2001.
- [13] K. Y. Wong, "Critical success factors for implementing knowledge management in small and medium enterprises", *Industrial Management and Data System*, vol. 105, no. 3, 2005, pp. 261-279.
- [14] R. Dawson, "Knowledge capabilities as the focus of organizational development and strategy," *Knowledge Management*, vol. 4 no. 4, 2000, pp. 320-327.
- [15] Y. Ning, Z. Fan, and B. Feng, "Knowledge capability: a definition and research model," In *Proceedings of Knowledge Science, Engineering and Management*, vol. 4092, 2006, pp.330-340.
- [16] B. Jones, and R. Dawson, "Scanning, sensemaking and pattern recognition", *ABN Report*, vol. 7, no. 6, 1999, pp. 8-11.
- [17] B. P. Nikolaj, S. C. Karina and J. Mouritsen, *Knowledge Management and Intellectual Capital: Establishing a Field of Practice*, New York, USA: Palgrave Macmillan, 2005.
- [18] M. H. Chang, and J. E. Harrington, "Multimarket competition, customer search and the organizational structure of multi-unit firm, *Management Science*," vol. 49, no. 4, 2003, pp. 541-552.
- [19] M. Lemon, and P. S. Sahota, "Organizational culture as a knowledge repository for increased innovation capacity," *Technovation*, vol. 24, no. 6, 2004, pp. 483-499.
- [20] T. P. Mullen, and M. A. Lyles, "Toward improving management development's contribution to organizational learning," *Human Resource Planning*, vol. 16, no. 2, 1993, pp.35-49.
- [21] S. C. Wheelwright, and K. B. Clark, *Revolutionizing Product development- Quantum Leaps in Speed Efficiency and Quality*, The free Press, New York, 1992.
- [22] T. L. Ju, C. Y. Li, and T. S. Lee, "A contingency model for knowledge management capability and innovation," *Industrial Management and Data System*, vol. 106, no. 6, 2006, pp. 855-860.
- [23] J. A. Nazari, and I. M. Herremans, "Extended VAIC model: measuring intellectual capital components," *Journal of Intellectual Capital*, vol. 8, no.4, 2003, pp. 596-609.
- [24] S. Slatter, *Gambling on Growth: How to Manage the Small High Tech Firm*, UK: John Wiley & Sons Ltd, 1992.
- [25] de la Mothe, John and F. Dominique, *Knowledge Management in the Innovation Process: Business Practices and Technology Adoption*, Amsterdam: Kluwer Academic Publishers, 2001.
- [26] J. B. William, A speech for American Bar Association, Section of Business Law, Litigation, and Tort and Insurance Practice entitled "Antitrust enforcement and high technology markets "in California, USA, 2004.
- [27] G. Roos, and J. Roos, "Measuring your company's intellectual performance," *Long Range Planning*, vol. 30, no. 3, 1997, pp. 413-426.
- [28] A. Zhou, and D. Fink, "The intellectual capital web: a systematic linking of intellectual capital and knowledge management," *Journal of Intellectual Capital*, vol. 4, no.1, 2003, pp. 34-48.
- [29] A. Lönnqvist, and P. Kujansivu, "Designing and implementing an intellectual capital management system: applying the meritum guideline in practice," *Knowledge Management*, vol. 1, no. 3, 2007, pp. 276-291.
- [30] L. Edvinsson, and M. S. Malone, *Intellectual Capital: Realizing Your Company's True Value by Finding Its Hidden Brainpower*, New York, USA: Harper Business, 1997.
- [31] H. Rau, "Intellectual assets and investment professionals: the view of the users," *Conference Intellectual Assets and Innovation: Value Creation in the Knowledge Economy Ferrara*, 2005, October 20 – 22.
- [32] L. Hunter, E. Webster, and A. Wyatt, "Measuring intangible capital: a review of current practice," *Australian Accounting Review*, vol. 15, no.36, 2005, pp. 4-21.
- [33] J. Bessant, and T. Venables, *Creating Wealth from Knowledge: Meeting the Innovation Challenge*, UK: Edward Elgar Publishing Limited, 2008.
- [34] A. A. Nermien, *Comprehensive Intellectual Capital Management: Step by Step*, Canada, USA: John Wiley & Sons, Inc, 2003.
- [35] I. Dierickx, and K. Cool, "Asset stock accumulation and sustainability of competitive advantage," *Management Science*, vol. 35, no. 12, 1989, pp. 1504-1511.
- [36] J. Guan, "Comparison study on industrial innovation between china and some European countries," *Production and Inventory Management*, vol. 43, no. 3-4, 2002, pp. 30-36.
- [37] G. C. Elias, and F. J. C. David, *Knowledge Creation, Diffusion, and Use in Innovation Networks and Knowledge Clusters*, Westport, USA: Praeger Publishers, 2006.
- [38] B. D. Leonard, "Core capabilities and core rigidities: a paradox in managing new product development," *Strategic management*, vol. 13, no.51, 1992, pp. 111-125.
- [39] P. M. Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization*, Doubleday, New York, NY, 1990.
- [40] S. Hanninen, and I. Kauranen, "Product innovation as a micro strategy: the innovation-based diversification view," in Carayannis, E. G. and Formica, P. (Eds.), *Knowledge Matters: Technology Innovation And Entrepreneurship in Innovation Networks and Knowledge Clusters (INKC): A Comparative Socio-Technical Systems Approach in the US, Europe And Asia*, Palgrave Macmillan, Hamshire, United Kingdom, 2008.

APPENDIX

ORGANIZATIONAL KNOWLEDGE CAPABILITIES ASSESSMENT
(OKCA) QUESTIONNAIRE

Name of company: _____

Section A - Demographics

Please **tick** the appropriate box to indicate you agree or disagree with the following statements. Please note that your responses are voluntary and anonymous.

1. I am a

Female	
Male	

2. My company belongs to which technology cluster (you could select more than one)

IT/Telecommunication	
Semiconductor/Electronics	
Biotechnology/Life Science	
Nanotech/Optoelectronics/Precision Engineering	
Energy/Environmental Engineering	
Professional Services	
Other (please specify):	

3. Number of employees in my company

Less than 10	
10 – 49	
50 – 99	
100 – 300	
300 +	

4. My company has been established for

0 – 3 years	
4 – 6 years	
6 - 9 years	
10 years or above	

5. My company annual turnover is around

Less than HK\$ 5M	
HK\$ 5M - \$ 10M	
HK\$ 11M - \$ 49M	
HK\$ 50M - \$ 99M	
HK\$ 100M or above	

6. My Job rank is

Top Management	
Senior/Middle Management	
R&D/Engineering/Technical Staff	
Supporting Staff	
Other (Please specify):	

7. My Department is

Management Office	
Marketing/Sales	
R&D/Engineering/Technical	
Finance	
Human Resources	
Administration	

Other (please specify): _____

8. I have been working with my present organization for

0 -3 years	
4 – 6 years	
7 – 9 years	
10 years or above	

9. My total working experience is

Less than 5 years	
5 – 9 years	
10 – 15 years	
15 – 19 years	
20 years or above	

10. My education level is

High school graduate	
Certification/Diploma	
Undergraduate Degree	
Master Degree	
Doctoral Degree	

Section B – Knowledge and Innovation Capabilities

Please **tick** the appropriate box to indicate you agree or disagree with the following statements. Please note that your responses are voluntary and anonymous.

1. Knowledge City Capability

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

Hong Kong as a Knowledge City		1	2	3	4	5	6	7
1.1	Government provides a strategic vision and development plan to promote Hong Kong as a knowledge based society							
1.2	Availability of agencies to promote the development of Hong Kong as a knowledge based city							
1.3	Hong Kong possesses ability to generate, attract and retain highly skilled citizens and knowledge workers in different domains							
1.4	Hong Kong provides low cost access to advanced Information and Communication Technologies (ICT) for all citizens							
1.5	Hong Kong provides a climate conducive to the production and dissemination of new and innovative knowledge based goods and services							
1.6	Government provides support of research, business innovation and entrepreneurship							
1.7	Assurance of equal participation and involvement of all citizens							
1.8	Enhancement of the inclusive, international and multi-ethnic character of the city							
1.9	Geographic proximity to markets							

2. Structural Capability

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

Organizational Structure		1	2	3	4	5	6	7
2.1	My organization structure							

	facilitates learning of new knowledge							
2.2	My organization structure facilitates the creation of new knowledge							
2.3	My organization structure facilitates the sharing of knowledge							
2.4	My organization structure facilitates the transfer of new knowledge across structural boundaries							

3. Cultural Capability

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

	Organization Culture	1	2	3	4	5	6	7
3.1	Orientation towards the acquisition, conversion, application and protection of knowledge							
3.2	Development of a culture that encourages innovations							
3.3	Value on job training and learning new knowledge							
3.4	Overall organizational vision and objectives are clearly stated							
3.5	Foster an open, cooperation and trust cultural conducive to knowledge learning and sharing							
3.6	Top management supports the role of knowledge in the enterprise's success							

4. Learning Capability

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

	My organization	1	2	3	4	5	6	7
4.1	Has process for acquiring knowledge about our customers							
4.2	Has process for generating new knowledge from existing knowledge							
4.3	Has process for acquiring knowledge about our suppliers							
4.4	Has process for distributing knowledge throughout the organization							
4.5	Has process for acquiring knowledge about new products/services within our industry							
4.6	Has process for exchanging knowledge between individuals							

5. Knowledge Conversion Capability

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

	My organization	1	2	3	4	5	6	7
5.1	Has process for filtering knowledge							
5.2	Has process for transferring organizational knowledge to individuals							
5.3	Has process for absorbing knowledge from individuals into the organization							
5.4	Has process for integrating different sources and types of knowledge							
5.5	Has process for organizing							

	knowledge							
5.6	Has process for replacing outdated knowledge							

6. Knowledge Application Capability

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

	My organization has improved its knowledge ability to	1	2	3	4	5	6	7
6.1	Develop new products/services							
6.2	Establish processes to solve new problems							
6.3	Match sources of knowledge to problems and challenges							
6.4	Improve and streamline the internal processes							
6.5	Locate and apply knowledge to changing competitive conditions							

7. Knowledge Protection Capability

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

	My organization has improved its knowledge ability to	1	2	3	4	5	6	7
7.1	Develop processes to protect knowledge from inappropriate use inside the organization							
7.2	Develop processes to protect knowledge from inappropriate use outside the organization							
7.3	Clearly communicate the importance of protecting knowledge							

8. Technology Capacities

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

	Technology Capabilities	1	2	3	4	5	6	7
8.1	My company has mechanism to encourage and reward inventiveness and creativity							
8.2	My company has technology development roadmaps for product development							
8.3	My company has a department for R&D/technology development							
8.4	My company has involved different functional groups /customers/suppliers in innovation process							
8.5	My company builds and develops contacts and collaborate with other firms, universities and R&D centres for new product/service development							
8.6	My company utilizes resources from Government, Science Park, universities or R&D centres for R&D projects							
8.7	My company has mechanisms to track and trace progress of R&D projects							
8.8	My company has good understandings of competitors core technology competence							

9. Marketing Capabilities

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

	Marketing Capabilities	1	2	3	4	5	6	7
9.1	My company has knowledge of							

	different market segments								
9.2	My company has relationship management with customers								
9.3	My company has an effective marketing intelligence system								
9.4	My company has specialized personnel responsible for marketing and sales activities								
9.5	My company has tracking system of customer satisfaction level								
9.6	My company provides after sales support services								
9.7	My company maintains good brand image and corporate image								

30% - 39%	
40% - 49%	
50% - 59%	
60% - 79%	
80% to 100%	

14. My organization has introduced new Services as a percentage of all services in the company over the last 3 years

Less than 5%	
5% - 9%	
10% - 19%	
20% - 29%	
30% - 39%	
40% - 49%	
50% - 59%	
60% - 79%	
80% to 100%	

Section C – Organizational Performance

Please indicate (by ticking the appropriate box) to indicate you agree or disagree with the following statements. Please note that your responses are voluntary and anonymous.

10. Product and Service Performance

Scale: 1: Strongly Disagree 2: Disagree 3: Slightly Disagree 4: Neither Agree nor Disagree 5: Slightly Agree 6: Agree 7: Strongly Agree

	Products and services performance	1	2	3	4	5	6	7
10.1	My company's products in general are competitive							
10.2	My company's services in general are competitive							
10.3	My company's technologies in general are competitive							

15. The average annual sales growth rate over the last 3 years is

Less than 5%	
5% - 9%	
10% - 19%	
20% - 29%	
30% - 39%	
40% - 49%	
50% - 59%	
60% - 79%	
80% to 100%	
100%+	

11. The average R&D personnel as percentage of my organization's total employment for the last 3 years is

Less than 5%	
5% - 9%	
10% - 19%	
20% - 29%	
30% - 39%	
40% - 49%	
50% - 59%	
60% - 79%	
80% to 100%	

12. The level of R&D investment in new products/services over the total revenue for the last 3 years is

Less than 5%	
5% - 9%	
10% - 19%	
20% - 29%	
30% - 39%	
40% - 49%	
50% - 59%	
60% - 79%	
80% to 100%	

13. My organization has introduced new products as a percentage of all products in the company over the last 3 years

Less than 5%	
5% - 9%	
10% - 19%	
20% - 29%	

End of the survey