Relationship of Knowledge Management Activities and Effectiveness among High-tech Companies in Taiwan

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In the knowledge economy era, effective use of knowledge management (KM) systems can confer competitive advantage. The purpose of this study is to understand the relationships between individuals and organizations undertaking KM activities and the effectiveness of those activities. Using both qualitative and quantitative approaches, this study investigates the relationship between KM activities and knowledge-management effectiveness (KME) in high-tech companies in Taiwan. An empirical survey and in-depth interviews with focus groups are conducted, and a new inventory for measuring KM activities and KME is thus developed. It is found that business KM activities and KME vary among knowledge workers in accordance with demographic variables and organizational nature. It is also found that KM activities affect KME to a certain extent, and that organizational KME can feedback on (and thus affect) KM activities.

Keywords: Knowledge Management, Taiwan, KM Effectiveness

1. Introduction

In the contemporary knowledge economy, organizations continually change in response to changes in the external environment. To meet modern business demands and keep up with changing trends knowledge workers (workers with specialist skills in knowledge management) have to make continuous adjustments [16]. For example, a firm should be able to respond to organizational knowledge quickly in a manner that improves overall satisfaction with the knowledge-management team. Allee [2] defines KM as a managerial mechanism which includes knowledge creation, maintenance, sharing, and renewal. High-tech industries have been the main focus of studies on knowledge workers and knowledge management (KM) [28, 45], and the information systematically acquired from such industries is the basis of current concepts of Knowledge Management and Knowledge Management Effectiveness. The latter is assessed in terms of the availability of organizational knowledge, and the use made of it, when a firm operates its knowledge management system. Adams and Lamont [1] coined the term "organizational knowledge management system effectiveness" to describe this concept, but their proposal did not extend to the construction of an empirical model. Establishment of a link between KM initiatives and business performance will require case studies leading to the development of an innovation

framework to establish current industry practice [34].

Despite the extensive work that has been done in this area, there is no single model that captures the full range of organizational dynamics and interactions that exist in KM. In practice, the KM process is likely to be circular, involving feedback as the results earlier knowledge exploitation are used to modify knowledge acquisition and management activities. In an organization, however, this circular practice is often codified in a linear model. For example a quantitative empirical description of KM activities leads to the formulation of activity rules prescribing the business practice and logic for knowledge acquisition and management. The nature of organizational reality means that KM and KME are best represented through a combination of quantitative and qualitative approaches that depict KME in both linear and interactive models.

In KM research, inter-organizational heterogeneity and diversity are often ignored, and the extent to which differences in KM may cause differences in effectiveness, efficiency, and performance, is unknown. Turban and Aronson [42] give three reasons for the assessment of KM effectiveness: to provide a basis for company valuation, to stimulate management to focus on what is important, and to justify investments in KM activities. Few researches have focused on the questionnaire development for the study of KM and its effectiveness [39]. Therefore, it is important to construct adaptable questionnaire to measure KM activities and KME.

This study initially explores the demographic factors and organizational characteristics potentially differentiating KM activities and KME in different organizations, and the relationships between them. Secondly, this study will construct metrics for KM activities and KME for Taiwan's industries. The constituent elements, dimensions, and indicators of KME are explored, and a KME model is developed that is supported by both theory and empirical data. Five representative companies are included in the initial case studies and five hypotheses related to KM activities and KME, (based on inference from in-depth interviews conducted with KM personnel) are proposed and tested.

2. Literature Review

2.1 Knowledge Workers

Ulrich [43] suggests that organizations would benefit from capturing the tacit knowledge of its employees and making it available for commercial exploitation. The term knowledge workers' refers to workers who are well educated, capable of learning, able to perform with self-motivation, and committed to their professions (rather than the organizations to which they belong). As such, knowledge workers are invaluable organizational assets [17]. T The roles of knowledge workers differ, according to varying job requirements; but, in general, they engage in data creation [16], and generate value-added proposals exploiting that data [48]. It is axiomatic that, the role of knowledge workers is critical to KM activities [32].

2.2 KM Activities in Knowledge Workers and Organizations

In managerial practice, the term "organizational knowledge" refers to knowledge that is shared with others and which helps to create organizational value [4]. Such

knowledge can be explicit or implicit [22], and organizations with different views on knowledge perform differently in terms of KM activities [18], [21]. "The organization designs KM processes that best suit the epistemologies of their employees in order to ensure effective and efficient systems to manage their knowledge" [31, pp.778-79]. The process perspective' stresses the procedures that are developed from organizational management activities, and describes how organizations pursue KM activities with appropriate managerial strategies [46].

"The organization's high-level strategic objectives and measures need to be translated into actions that each individual can take to contribute to the organization's goals" [15, pp.50-51]. Full exploitation of the available knowledge is likely to depend on the KM expertise of the workforce. Robinson et. al. [34, p 16.] showed that "measurement of employee' characteristics is important as the quality of service offered by organizations depends on the expertise, training and ability of its staff." Since employee expertise influences quality of service, it seems possible that KM expertise is one relevant facet of this expertise. In-depth interviews on the application of KM conducted by the Center for Education Research and Innovation (CERI) [6] established that KM activities are of great significance in high-tech industry. In the same study, significant differences were found in knowledge creation and application among high-tech companies. It is also apparent that various knowledge workers perform differently in the implementation of KM activities in organizations [2]. The individual-level factors are not limited to locus of control, knowledge, ability, etc. [44], and they consider that demographic variables, such as gender, marital status, education, age, tenure, position, and department might also be important, in individual KM activity. Accordingly, this study hypothesizes.

Hypothesis 1: Differences in demographic variables of knowledge management workers are significantly related to differences in KM activities.

Organizational factors, such as organization size, influence administrative practices [34]. Organizations tend to have their own characteristic ways of managing their KM activities [33]. In general, the nature of their business dictates that high-tech companies are more involved in KM activities than are manufacturing, finance, and service industries As a result, high-tech industry serves as a benchmark in the promotion of KM activities for all organizations. Various factors, including type of business, capital base, number of employees, and the general culture of a business affect the nature of KM activities [24]. As a result, this study hypothesizes:

Hypothesis 2: Differences in the organizational environment of knowledge management workers are significantly related to differences in KM activities.

2.3 Measuring KME

Robinson et al. [34] suggest that measurement of business performance involves assessing compliance with models such as the excellence model, balanced scorecard, and continuous improvement. To assess the effect of KM, this study requires more specific indicators. Organizational effectiveness, one possible indicator of KM's effect, refers to the extent to which an organization achieves its objectives within the totality of the consumed resources [10]. Similary, Hoy & Miskel [23] argue that organizational effectiveness can be assessed in terms of the goals and resource allocation of an organization. In assessing these factors, researchers such as Treacy &

Wiersema [41] have developed measurements using particular (limited) variables from the process perspective. However, they have failed to come up with a comprehensively based measurement. With respect to questionnaire item inventory development, self-evaluation has been commonly adopted to test reliability and content validity.

However, as noted above, knowledge workers tend to perform individually to promote KME [39], [5], and such differences in performance appear to result from such factors as gender, marital status, education, age, tenure, position, and department. As a result, this study hypothesizes:

Hypothesis 3: Differences in the demographic variables for knowledge workers are significantly related to differences in KME.

Organizations also tend to have their own methods of promoting KME [19], [38]. As previously noted, organizational variables such as capital, number of employees, and corporate learning styles' might produce these differences. As a result, this study hypothesizes:

Hypothesis 4: Differences in the organizational environment in which knowledge workers operate are significantly related to differences in KM effectiveness.

According to Sharkie [35], an organization should develop capabilities to handle change and learn rapidly. KM techniques which confer the ability to create knowledge and continue to learn can become a competitive advantage, because innovative knowledge developed today will become the core knowledge of tomorrow [50]. To build and maintain competitive advantage, a firm should continuously develop their KM activities and mechanisms. Adams & Lamont [1, p.145] argue that "the bundling of the KM system with other firm resources and core competencies is the key to developing and maintaining sustainable competitive advantages". KM activities should facilitate the more efficient and effective utilization of a firms resources. KM activities obviously have an impact on KME [39], [5], [3], [40], [13], [27], [37], [20]. It is assumed that the KM activities associated with the implementation of a KM system will improve the knowledge management environment and contribute directly to improved performance, efficiency, and effectiveness, which can be measured as KME. According to Adams & Lamont [1, p.148], "the organizational KM system effectiveness construct rates the effectiveness of the organization's knowledge acquisition and management systems by measuring the relative contribution that the information system function, and specifically the KM system, provides in the core competencies and competitive advantage development processes". This view is essentially a linear one, with KM leading to KME. Going further, it seems likely that the monitoring of KME will feedback on their KM activities, leading to the identification and fostering of "best practices".

2.4 Exploratory Qualitative Study

An initial exploratory study was undertaken to identify senior managers' and specialists' understanding of the knowledge management construct and to identify what programs, if any, firms have in place to manage the flow of knowledge" [11, p.42]. Yin [49] has argued that case studies are the most suitable research methodology for the exploration of existing phenomena in real life. The present study

conducted an exploratory qualitative study of the subjects under consideration. The study involved in-depth interviews with five companies in high-tech industries. Background information for the case companies, and individual respondents, is provided in Table 1.

Table 1 *Background Information of the Interviewed Companies and Experts (* $: US dollars)

Case Number	A	B	C	D	E
Capital	$9,375 millions	$12,046 millions	$208.75 millions	$187.5 millions	$76,875 million
Business	Integrated Circuit	Integrated Circuit	Semiconductor	Communication	Semiconductor
Company Location	Hsinchu County, Taiwan	Kaohsiung City, Taiwan	Hsinchu City, Taiwan	Taipei City, Taiwan	Hsinchu County, Taiwan
Interview Location	Hsinchu Headquarters	Kaohsiung Headquarters	Tainan Branch Office	Taipei Headquarters	Hsinchu Headquarters
Organizational Culture	Innovation	Innovation	Adaptation	Adaptation	Innovation
Organizational Leaning Type	Organizational Society	Organizational Society	Team Work	Organizational Society	Team Work
Interviewee					
Department	KM Application and Development	Manufacturing Engineering	Knowledge Engineering and Development	Application and Service	Management Information System
Gender	Male	Male	Male	Male	Female
Title	Manager	Manager	Member	Manager	Member
Education	MBA of Technology , National Chiao Tung University, Taiwan	MBA, National Cheng Kung University	MS of Material, U. S.	Bachelor of Agriculture Chemistry, National Taiwan University, Taiwan	MBA, National Sun Yat-Sen University
Experience	RandD Engineer	Mechanical Engineer	Member of TQM	Manager of Marketing	Member of Information Management
Tenure	4 years	3 years	2 years	2 years	1.5 years
Employees of KM Unit	20	20	3	30	10

The study used the qualitative approach proposed by Lincoln [29] for individual specialist case interviews.

There are four criteria used to guide this study. The first is objectivity, involving an assessment of whether the researchers are able to compile and analyze the data provided by the interviewees without subjective bias. This study is intended to objectively present the original data provided by the interviewees. The contents of the interviews have not been revised or modified with value-loaded words, so that a neutral observation can be achieved.

The second criterion is dependability, which refers to the importance and uniqueness of the experience of the interviewees It is ensured by specifying a consistent research process, which will produce dependable data on which to base judgements. In its

selection of interviewees, this study treated chief executives or personnel in charge of KM as the subjects of the first priority and has received their agreement in the arrangement and content of the interviews.

The third criterion is reliability. This study treats personnel in charge of KM as the subjects, in order to most efficiently and accurately acquire the present status of KM through interviews.

Finally, transferability or external validity refers to the extent to which the interviewees' feelings and experiences collected from their statements form an effective description of the general situation in the industry. The interviews were collected by tape recording and note taking. The contents of the recordings and notes have been compiled and confirmed with the interviewees.

2.4.1 Background Information of interviewed Companies and Experts

This study used in-depth interview technique of Lincoln [29], to select expert respondents for these cases, KM managers or specialists in representative high tech companies in Taiwan. These are used to explore KM practices. High-tech industry is of great importance for research into KM [33]. As the interviewee from Case C observed:

> …As far as Taiwan's KM expertise and contributions are concerned, the majority of high-tech products in US business come from Taiwan. Taiwan has done a great deal in sharing its KM with companies in the US. But US companies do not share as much with those in Taiwan. When production of the 12-inch wafer began, the US and Germany had only one assembly line each and possessed few machines. When we started our production in the Tainan Science-based Industrial Park, more machines were in use in the assembly line. As a result of the successful operation of our assembly line, the US began to acquire knowledge from Taiwan. In evaluating the issue of performance or effectiveness of KM, I believe that Taiwan's experience would be helpful to the US.

As high-tech companies become more specialized, and as social networks among the staff members of such companies flourish, professional workers in this field will become recognized knowledge workers [16]. The interviewee from Case B observed that "… knowledge managers and knowledge workers are those who set up an organizational structure for the creation of organizational knowledge". The interviewee from Case E argued that "… willingness and enthusiasm are a must for knowledge workers to learn and create an understanding of business and organizational culture". The same respondent noted that knowledge workers in high-tech companies are:

> … those workers who are willing and enthusiastic to learn as well as be employed to create knowledge … Our company will not set different standards to evaluate male or female workers who make different contributions to the company … What really counts is your effort, your willingness to learn and your perseverance.

In terms of organizational nature, the interviewee from Case A maintained:

> … we highly value our KM groups … the mission of the KM groups is to connect new resource systems in the organization … In our company, KM groups can be categorized as managerial leadership groups' and lecturer groups'..

The interviewee from Case D observed:

> …In my experience of implementing KM in IBM, the president considers that a company should streamline its levels of management since redundant levels of management will obstruct the implementation of KM.

Cross [9] proposed that KM would not improve business performance simply by using technology to capture and share the lessons of experience. The argument appears to be that organizations with fewer managerial levels tend to have greater emphasis on KM activities and greater KME. With respect to the question of whether a separate KM department should be established, the interviewee from Case A observed:

> …Our company set up a department of KM application and development on November 1, 2000. We have seen an improvement of our business operation as a whole.

It therefore seems that the institution of a separate KM department is likely to enhance both KM activities and KME. In terms of the scale of such a KM department, the interviewee from Case A pointed out that:

> … There are only 10 people in our department for the time being … We can afford to carry out most KM activities smoothly. We even made public our KM patterns to share our experience with our counterparts in the industry.

With respect to the influence of KM activities on KME, the interviewee from Case A observed:

> …KME will result in multiple linkages, facilitating the development of interpersonal intimacy and trust among the staff. The organization will also receive the most up-to-date resources and valuable experiences. Besides, job-related problems will be handled and solved in a rapid fashion.

The interviewee from Case B noted:

> …Rather than being just a money-making tool, KM is very important to help and improve organizations. As long as the organization continues its operation, it needs KM to make continuous improvement … The effect of organizational effectiveness, however, is not fully recognized … Nearly a dozen organizations that performed KM called off their KM activities a less than a year after implementation … A great deal of KM performance is packaged in a very nice way to simply please the boss. KM enhances the achievement and maintenance of knowledge for organizations. Therefore, the productivity resulting from the development of organizational knowledge can work its way in an invisible fashion.

The interviewee from Case E observed:

> …After understanding the integration of knowledge in the organization, we measured the effectiveness of KM from the dimensions of system performance

and employees' satisfaction.

With respect to feedback on organizational effectiveness in KM, the interviewee from Case A stated:

> …We had know-how transferred and shared from our plants in the Silicon Valley at first. Now we are feeding back our well-run results to them. IC counsellors share their know-how with those units that are in need of transformation and improvement. When IC counsellors receive the feedback, they pass it along to the parent community.

The interviewee from Case E observed:

> …With the institution of knowledge resources in our company, colleagues had access to the knowledge they needed for performing their tasks. The application of acquired knowledge helped them to achieve the task and enhance their effectiveness. The process and results of knowledge application fed back into the system. In this way, potential users have benefited and practical knowledge has accumulated.

Therefore, in those five firms' practice summarized in Table 2, hypotheses H1 to H4 are confirmed.

Table 2 *Results of the Interviewed Experts in the Case Companies*

	KM Activities	KM Effectiveness
Demographic Variables	BCE	ABE
Organizational Nature	ABE	ACE
KM Activities	None	ABCDE

Robinson et al. [34, p.14] showed that "construction organizations have often been criticised for resistance to change and for failing to adapt innovation approaches to improve future business performance."(p.14) Organisations that emphasise the measurement of KME are likely to find it is an agent of change, providing feedback to guide the modification of their KM activities.

As a result, this study hypothesizes:

Hypothesis 5: KM activities and KME are significantly correlated.

2.5 Conceptual Framework and Showing of Hypotheses

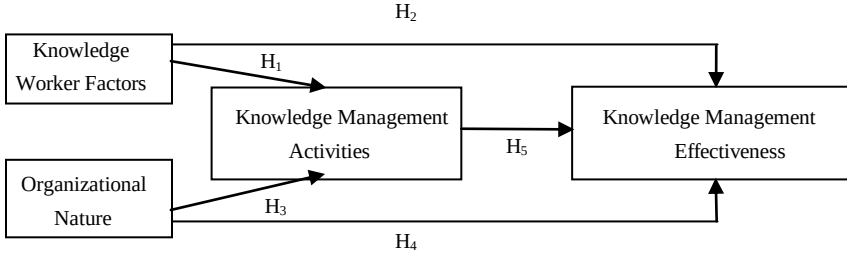

Figure 1 *Conceptual Framework*

The literature review and the preliminary qualitative study allowed the identification of the demographic variables of knowledge workers and the organizational nature of

their employing firms as being of probable special significance in the assessment of knowledge workers, KM activities, and KMEs.

The conceptual framework for the study is shown in Figure 1, which illustrates the presumed relationship among the variables of interest. Its constituent hypotheses, discussed above, are based on the literature review and exploratory qualitative study.

3. Empirical Study

3.1 Questionnaire Development

To determine the relationship between KM activities, KME, organizational and demographic factors, this study initially used literature review and in-depth interview to establish a link between theory and practice before formulating a generalization. This study also suggests direct relationships H1 to H4 between environmental factors and KM effectiveness, and an indirect relationship via KM activities. An interactive model would incorporate feedback from KME monitoring, leading to modification of KM activities. The linear model was based on the literature review, with an interactive model proposed after in-depth interview.

In the second section, which uses content analysis to measure the relevant parameters, valid indicator items must be identified. There were three investigative stages. The first used 8 previously published questionnaires and the statements from the 5 in-depth interviews, which provided a basis for draft-questionnaires, as proposed by [11] "two code sheets were developed to list the dimensions that might potentially be included" investigating KM activities and KME. An inventory of dimensions and measuring indicators was developed from an analysis of management practice and experience obtained from the qualitative research described above, in association with findings from previous research. The latter 8 questionnaires were previously used by the American Productivity and Quality Center [3], The Know Network [40], David Skyrme Associates [13], Levett & Guenov [27], Storck & Hill [37], Gold et al. [20], Becerra-Fernandez & Sabherwal [5], and Sveiby [39].

KM research has been characterized by three main orientations—(i) organizational theory (OT) [33], (ii) human resource management (HRM) [7], and (iii) information technology (IT) [12]. Following Allee [2] and Draft [10] this study draws on published work in these disciplines, and the views of practicing IT professionals, to get an initial list of items, which could then be reworded or removed to produce the pilot questionnaire instruments for KM activities and KME study.

For the dimensions and constituent elements of *KM activities* in the present study, the categorization of KM activities by Allee [2] that is, knowledge creation, knowledge maintenance, knowledge sharing, and knowledge renewal. The operational definitions of the four indicators were as follows. Firstly, knowledge creation is defined by describing the organisational procedures by which knowledge is created. Secondly, knowledge maintenance describes the procedures undertaken by key database managers to arrange, store, collect, display, analyse, categorize or apply the knowledge. Thirdly, knowledge sharing was defined in terms of the common organizational language used to describe the knowledge, and the procedures, techniques and skills used to promote its exchange, including electronic reports or

Table 3 *Indicators of KME*

Indicator of KME	Knowledge Adaptation Effectiveness			Knowledge Goal Attainment Effectiveness			Knowledge Integration Effectiveness			Knowledge Latency Effectiveness		
	Knowledge Adaptability	Knowledge Innovation	Knowledge Growth & Development	Knowledge Achievement	Knowledge Quality	Knowledge Efficiency	Knowledge Satisfaction	Knowledge Climate	Knowledge Communication	Knowledge Loyalty	Knowledge Motivation	Knowledge Identity
[3]	●		●	●	●	●	●	●		●	●	
[40]	●	●	●	●	●		●	●	●	●	●	●
[13]	●	●	●	●	●		●	●	●	●	●	●
[27]	●	●	●	●	●	●		●	●	●	●	●
[37]			●	●		●	●			●	●	
[20]	●	●	●		●	●						
[5]	●		●	●		●	●					
[39]			●	●			●	●	●	●	●	
Total	6	4	8	7	5	5	6	5	4	6	6	3

● represents that KME is included in the articles;

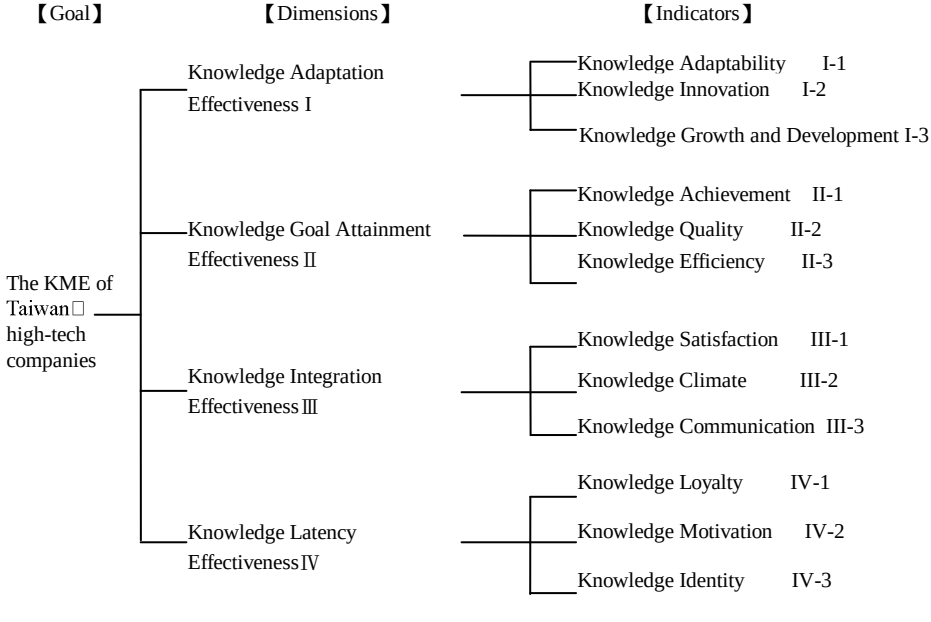

Figure 2 ***The Dimensions and Indicators of KME***

communication technologies. Finally, knowledge renewal was defined in terms of the procedures for giving up the unused and obsolete organizational knowledge and replacing it with a more currently useful version.

For the dimensions and constituent elements of *organizational KME*, the perspective of organizational effectiveness proposed by Hoy & Miskel [23] was adopted, modified to fit the context of knowledge management effectiveness in Taiwan. This classifies relevant questionnaire item inventories into four dimensions. The inventories include 13 items of knowledge-adjustment effectiveness, 14 items of knowledge objective-achieving effectiveness, 14 items of knowledge-integration effectiveness, and 10 items of knowledge-potential effectiveness, as shown in Table 3. Their categorization (presented in Figure 2) was.

Using this classification, the study developed KM activity questions for the survey from case interviews and consultations with 12 management experts noted above, and from the published work tabulated below, from the three discipline orientations noted above.

3.2 Sample and Methodology

Employees from the KM departments of 17 companies from Taiwan's high-tech sector, with a reputation for good KM practice, are sampled in the final section. The employees are typically high level managers. The sampling regime is based on the assumption that these firms have a high incidence of good KM behaviour and practice, so it is deliberately non-random, so-called "judgement sampling."

A measuring instrument should meet recognised standards of reliability and validity. The results are analysed based on the acceptance criteria proposed by Walsh and Betz [47]. A Likert-type 6-point scale was adopted for the inventory of KM activity and KM effectiveness.

Reliability refers to the consistency of a set of measurements or measuring instrument, which is an indication, in an attitude inventory survey, that the items are measuring the same dimension or attitude, and therefore have internal homogeneity. This study uses Cronbach'α coefficient as an indicator of reliability.

Validity has been separated into content validity and construct validity. The former relates to the extent to which the measures used in a study measure what they claim to, and may be validated by interview with panels of subject experts, and by use of previously published and validated measures. The latter relates to the soundness of both the theoretical basis of the construct and its current operational measurement. In other words, how clearly and consistently has it been defined in the literature, and how well does the present study conform to those previously published definitions.

The dimensions in the questionnaire used in the present study are derived from published theory and relevant literature, which should foster construct validity, Empirical evidence and in-depth interviews, with modification through consultation with specialists to better reflect the research subject, should achieve a high content validity.

Using this classification, the present study developed its KM activities and KME measuring items from case interviews, literature review, and consultations with 11 management experts and KM scholars. Satisfactory results were obtained for KM activity consistency (Cronbach's alpha coefficients ranged from 0.8571 to 0.9761)

and validity (face and construct factor loadings ranged from 0.660 to 0.946, the Eigen-value ranged from 1.412 to 6.497, and the cumulative variance was 92.716%). Satisfactory results were obtained for KME consistency (Cronbach's alpha coefficient ranged from 0.8256 to 0.9978) and for validity (face and construct factor loadings ranged from 0.792 to 0.973, the Eigen-value ranged from 1.048 to 11.737, and the cumulative variance was 92.716%).

A survey was then conducted to investigate KM practice in 17 high-tech firms. The technique of judgment sampling was used, which involved interviews and a survey with KM personnel from high-tech companies located in the Hsinchu and Tainan Science-based Industrial Parks in Taiwan. A pre-test questionnaire item inventory was developed and provided to experts for their evaluation. Student's *t*-test, ANOVA, and canonical correlation were used to test the hypotheses in the empirical study.

4. Results

A total of 222 valid samples were obtained from 17 companies. Data were analyzed with *t*-test, ANOVA, and canonical correlation. The results are presented in Tables 4 and 5.

It was found that certain demographic variables (gender, marital status, age, educational level, tenure, department, and job position) were associated with KM activities. Thus Hypothesis 1 was supported. In addition, certain demographic variables (gender, age, educational level, tenure, and job position) were found to have partial association with KME. Hypothesis 3 was thus also supported.

In addition, Hypothesis 2 was confirmed—in that business categorization, capital, and the number of employees were found to be associated with KM activities (at least in part). Moreover, Hypothesis 4 was also confirmed—in that business categorization, capital, and the number of employees were found to be associated with KME (at least in part).

Canonical correlation analysis (presented in Table 5) was conducted to test the correlation between KM activities and KME as hypothesized in Hypothesis 5_+. Knowledge creation (0.345), knowledge maintenance (0.699) and knowledge sharing (0.621) activities were highly correlated with knowledge adaptability (0.359), innovation (0.249), growth and development (0.683), efficiency (0.378), climate (0.239), communication (0.221) and identity (0.198) effectiveness. It was found that KM activities and KME were significantly correlated ($\rho = .734$, $p < 0.001$) overall. Hypothesis 5 was therefore supported.

5. Discussions

This study empirically examines links between constructs reflecting KM behaviours and practices, following Darroch [11].

A relationship between KM activities and KME in high-tech industries was confirmed. With this confirmed, the model of KM in the high-tech companies can be applied to measure non-financial resources or invisible assets as emphasized by Sveiby [39]. The measurement of KME should be influenced by the overall business strategy, which should also guide KM activities [34].

Table 4 *Results for T-test and ANOVA*

	KM activities							KME										
	Creation	Maintain	Sharing	Renew	Adaptability	Innovation	Develop Growth and	Achievement	Quality	Efficiency	Satisfaction	Climate	Communicat	Loyalty	Motivation	Identity
Knowledge Worker Factor																
Gender	0.041	0.969	0.715	0.199	0.865	3.354***	0.306	0.891	0.793	1.675+	1.760	0.264	1.597	2.227*	2.669**	0.157
Marital Status	2.823**	1.626	1.225	0.356	1.179	0.860	0.895	0.889	0.109	0.894	1.072	1.363	0.327	1.420	0.840	0.043
Age	5.587***	1.786	0.309	0.326	0.366	1.213	5.228**	3.561*I	0.143	0.451	2.033	0.697	0.132	0.704	0.346	2.122+
Education	0.059	0.995	0.849	3.170*	1.160	1.132	0.426	0.623	0.293	0.501	0.458	1.245	2.350+	0.019	1.142	0.068
Tenure	1.438	6.431***	2.771*	3.862**	0.369	2.321+	3.946**	0.790	0.471	1.125	0.352	1.757	0.744	0.626	0.823	1.952
Service Department	2.694*	4.533**	1.374	1.316	0.905	1.918	1.620	0.111	1.072	0.995	1.965	1.047	0.839	1.058	0.984	1.937
Position	0.076	9.833***	1.316	1.570	2.527+	3.614*	3.363*	1.502	0.162	1.186	1.125	0.105	0.626	0.679	4.052**	0.262
Organizational nature																
Industry	3.264**	2.037+	1.805+	2.138+	1.086	3.733**	0.237	0.946	0.426	0.458	1.107	1.105	0.562	1.920+	4.804***	3.202**
Capital	3.358**	4.722***	5.485***	0.500	6.167***	2.238+	0.482	2.394+	1.450	1.933	2.183+	0.238	0.259	0.997	2.512*	5.095***
Employee Number	2.052+	1.887	0.759	0.978	1.652	4.339**	0.272	0.116	2.637*	2.624*	2.608*	0.453	0.768	0.619	0.394	6.774**

+ $p<0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Table 5 *Canonical relationship between KM activities and KME*

Independent (X) KM activities	Canonical Variable X1	Dependent (Y) KME	Canonical Variable η1
Knowledge Creation	0.345***	Knowledge Adaptability	0.359***
Knowledge Maintenance	0.699***	Knowledge Innovation	0.249**
Knowledge Sharing	0.621***	Knowledge Growth and Development	0.683***
Knowledge Renewal	0.013	Knowledge Achievement	0.123
		Knowledge Quality	0.052
		Knowledge Efficiency	0.378**
		Knowledge Satisfaction	0.071
		Knowledge Climate	0.239**
		Knowledge Communication	0.221**
		Knowledge Loyalty	0.125
		Knowledge Motivation	0.128
		Knowledge Identity	0.198*
Abstracted Variance (%)	13.484%	Abstracted Variance (%)	8.333%
Overlap (%)	4.495%	Overlap (%)	25.000%
		ρ2	0.539
		P	0.734***

*** $p<0.001$; ** $p<0.01$; * $p<0.05$

The study confirmed that the demographic variables of knowledge workers are associated with both KM activities and KME. Organizations that place emphasis on recognition of these demographic factors among knowledge workers are more effective in facilitating the implementation of KM activities. The study thus confirmed that organizations should pay attention to the characteristics of knowledge workers to achieve its KM objectives and KM effectiveness. In a firms' performance plans, the valuation of KM activities and KME should provide a clear direction for everyone, motivating and providing guidelines for the process of developing KM activities and KME.

Finally, this study sought to elucidate the problem encapsulated in "knowledge is an intangible asset, and to measure the effectiveness of KM solutions becomes a challenge" [15]. It has been addressed by constructing a measurement instrument for KM activities and KME. The study found that both KM activities and KME are affected by organizational factors. High-tech companies organizational factors facilitate the implementation of KM activities and achieve greater KME. Companies which emphasise the promotion of KM activities achieve greater KME. In addition, companies with greater KME do better in terms of positive feedback on the implementation of KM activities. Measuring KME should be carried out as part of a regular performance review aimed at enhancing business processes to promote performance [14]. More targeted KM activities bring about greater KME since KM

activities and KME in high-tech companies are naturally strongly correlated. Similarly, auditors should consider the interactions of knowledge sharing activities and personal characteristics in formal or informal review processes [44].

6. Managerial Implications

Organizations should value their knowledge workers as the most valuable assets that they possess. Knowledge workers possess the expertise and know-how that make organizations competitive. In addition, organizations should pay more attention to the reciprocal relationships between KM activities and KME in order to create, maintain, share, and renew knowledge. Similarly, to address diverse epistemological beliefs it is essential to understand where and how in organizations the critical knowledge is used, which individuals or groups use it and what their requirements and views on knowledge creation are [31].

As proposed by Kaplan & Norton [25], [26] and by Sveiby [39], the present study confirms that organizational knowledge as measured by non-financial indicators can increase competitiveness. The results of this study could be used for a comparison and analysis of KME among organizations in other industries. This might assist organizations in adjusting their strategies for KM activities and thus achieve greater KME.

With the development of the instrument, new avenues of inquiry are opened [30]. The study adopted an integrated categorization method, which allows the experience and opinions of KM scholars and KM managers to be translated into objective measurements of intangible assets. There are no items specific to the industries analyzed in the empirical study [30], and the instrument could therefore be used in any knowledge-intensive industry.

7. Conclusions

Previous research has focused mainly on the organization itself as the level of analysis. In contrast, the present study has focused its investigation on the individual level. The Organization for Economic Co-operation and Development is in the process of developing measurements of KM activities and KME at the state level. Developments at all three levels are complementary. The results of the present study might offer some insights into the development of the measurement at the individual level. In addition, it is arguable that the development of performance measurement techniques is a better way to improve the actual effectiveness of boards rather than prescriptions for activities [36].

Future research could investigate the differences in KME among organizations in order to provide a more holistic view of this important field. Future studies could modify the questionnaire item inventory to explore the issue from different levels—group or organization—to achieve a better understanding of the contribution of KM to organizations. Future research could also undertake further exploration of the reciprocal relationship between KM activities and KME established in this study. Longitudinal studies or cross-sectional studies might also serve as a good option to better understand the relevant issues.

8. References

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