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Relationships between knowledge acquisition, absorptive capacity and innovation capability: an empirical study on Taiwan's financial and manufacturing industries

Shu-hsien Liao, Chi-chuan Wu, Da-chian Hu and Kuang-an Tsui

Department of Management Sciences and Decision Making, Tamkang University, Taipei, Taiwan, Republic of China

Abstract.

This study investigates the relationships between knowledge acquisition, absorptive capability, and innovation capability on Taiwan's knowledge-intensive industries using a structural equation model, which is constructed based on the data sampled from financial and manufacturing industries, and the 362 returned valid research samples. By testing five hypotheses, the research results find that absorptive capacity is the mediator between knowledge acquisition and innovation capability, and that knowledge acquisition has a positive effect on absorptive capacity. In addition, we used a multi-group approach and found that industry is a moderator between knowledge acquisition and innovation capability. Finally, a conclusion including research findings, discussion, implication, and future works is presented.

Keywords: absorptive capacity; innovation capability; knowledge acquisition; moderator analysis; structural equation modelling

Correspondence to: Shu-hsien Liao, Department of Management Sciences and Decision Making, Tamkang University, Taipei, Taiwan 251, Republic of China. Email: Michael@mail.tku.edu.tw

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1. Introduction

In 1965, Drucker proposed that knowledge would replace equipment, capital, materials and labour to become the key element in production. Three decades later, in 1993, he maintained that competitive advantage in the future will be determined by knowledge resources, or what is known as knowledge workers [1]. Rapid changes in business environment have shortened the cycle of core competitiveness and there is essentially no longer any long-term competitiveness. Therefore, businesses should maintain their competitive advantage by understanding the market conditions, innovating knowledge and promoting innovation. On the other hand, innovation is a field receiving a great deal of attention from companies in today's fast-changing business environment. Realizing that most firms and competitors within their industry have acquired the same level of competence in other areas of management, such as operations, human resources, marketing, strategy, and the like, many firms have begun to look to innovation as a key differentiating factor for competitive advantage [2]. As a result, knowledge is a very important resource for preserving valuable heritage, learning new techniques, solving problems, creating core competences, and initiating new situations for individuals and organizations.

However, innovation must rely on a base of common knowledge. Moreover, knowledge in an organization comes from both inside and outside the organization. Therefore, an organization's ability to absorb external knowledge, its absorptive capacity, is very closely related to knowledge acquisition. As a result, knowledge is a very important resource for preserving valuable heritage, learning new techniques, solving problems, creating core competences, and initiating new situations for individuals and organizations. Knowledge acquisition may be a power to encourage knowledge exchange and creation in the organizations in order to recognize their competitive advantages, such as intellectual capital [3]. In addition, knowledge is the key to achieving continuous innovation, so innovation and knowledge have a close relationship together. Therefore, knowledge management has become an important resource for businesses. Knowledge management covers an extremely wide range.

Several previous studies on innovation have already claimed that the firm's absorptive capacity has a significant influence on its innovations [4–5]. For example, Hill and Jones [6] stated that the foundation of a company's competitive advantage is, after selecting their unique competitive abilities, to make use of its absorptive capacity to develop its unique competitive abilities; however they made no suggestions on how to achieve it and how to improve or develop absorptive capacity. In this study, absorptive capacity is defined as the employees' ability to obtain external knowledge, and their willingness to transform this for usage in their firm's innovation capability. Absorptive capacity emphasizes the ability to obtain knowledge and the level of effort used to transform it for usage. Therefore, it can be seen that there is a close relationship between knowledge and the level of absorptive capacity. Overall, the characteristic of knowledge creates, on some level, a relationship between knowledge acquisition, absorptive capacity and innovation capability. As a result, it is still unclear whether or not knowledge acquisition influences either absorptive capacity or innovation capability.

Accordingly, this study investigates the relationships of knowledge acquisition, absorptive capability and innovation capability on Taiwan's knowledge-intensive industries. The structural equation model of the relationships among knowledge acquisition, absorptive capacity and innovation capability is constructed based on the data sampled from financial and manufacturing industries, and from which 362 valid research samples were received. The rest of the paper is organized as follows. Section 2 proposes the theoretical background and hypotheses. Section 3 constructs a research framework and measurement. Section 4 describes descriptive statistics and empirical results. Finally, Section 5 contains the conclusion, including research findings, discussion, implication, and future works.

2. Theoretical background and hypotheses

2.1. Relationship between knowledge acquisition and absorptive capacity

Researchers have identified many key aspects to the knowledge management process: capture, transfer and use [7]; acquire, collaborate, integrate and experiment [8]; create, transfer, assemble, integrate and exploit [9]; create, transfer and use [10–11]; as well as create and process [12]. Knowledge acquisition and creation are the first steps in the process of developing knowledge [13]. However, acquiring knowledge is the first activity in the broader activity of accepting knowledge from the external environment and transforming it into a representation that can be internalized, and/or used within an organization. Sub-activities include extracting knowledge from external sources, interpreting the extracted knowledge and transferring the interpreted knowledge. Hence, knowledge, once acquired, must be quickly and effectively disseminated to all parts of the firm [13].

Improved use of existing knowledge and more effective acquisition of new knowledge is also a key aspect of acquisition [14]. It includes the mechanisms and procedures for collecting information inside and outside the organization or creating knowledge [15]. Of course, the procedure of acquiring and identifying knowledge through the experience and reconciliation in an organization will assist administrative and technological innovation [1].

In addition, Zahra and George [16] highlight four distinct but complementary capabilities that compose a firm's absorptive capacity: knowledge acquisition, knowledge assimilation, knowledge transformation, and knowledge exploitation. Therefore, organizations with better knowledge acquisition will have a positive level of absorptive capacity.

Thus, this research proposes the first hypothesis as follows:

Hypothesis 1: Knowledge acquisition is positively related to absorptive capability.

2.2. Relationship between absorptive capacity and innovation capability

Cohen and Levinthal [4] defined absorptive capacity as: the ability to recognize the value of new information, to assimilate it, and apply it to commercial ends. It is also a key factor to innovation capability. Absorptive capacity is the ability to evaluate and utilize knowledge outside the organization in order to identify the organizational environment. This means that high absorptive capacity (higher education, employee development and innovation tendency) will lead to high performance [17].

In recent years, studies related to absorptive capacity can be divided into the following areas.

1. Absorptive capacity is related to an organization's existing knowledge and internal knowledge including human capital and technology [18–20].
2. Absorptive capacity is related to the external environment, such as government policies and rules, industrial interactions and risk [3, 21–23].
3. R&D expenditure will increase the absorptive capacity of an organization [24].
4. Intensity of learning will influence absorptive capacity [3].
5. Absorptive capacity is related to organizational strategies [20].
6. Absorptive capacity will increase the innovation and competitive advantage [17, 20–21].

Most studies have taken the numbers of patents and publications, or the usages of patents as the measure of absorptive capacity [22, 25]. On the other hand, other studies have taken the ratio of R&D expenditure and sales volume as the measure [26]. However, absorptive capacity is a tacit and complex construct, and thus very difficult to measure. Therefore, we took the four dimensions used by Mariano and Pilar [21]. They are (1) the links between the firm and the surrounding environment; (2) the level of knowledge and experience of the organization; (3) the diversity and overlapping of knowledge structure; and (4) the strategic posture for measuring absorptive capacity. This will avoid using a single index – such as R&D or R&D expenditure – to evaluate absorptive capacity.

Maintaining or increasing the absorptive capacity of an organization would incur R&D expenditure and its influence innovation capability positively. Therefore, once an organization can sustain absorptive capacity, this will link its research and practice together [25]. Innovation capability is related not only to product/process but also to technology and management [27].

Jantunen [15] found that most studies in the innovation literature stressed the importance of capacity in using external knowledge, that is, absorptive capacity influenced innovation capability. Moreover, interacting with external new knowledge will promote absorptive capacity [28]. Therefore, this research proposes the second hypothesis as follows:

Hypothesis 2: Absorptive capacity is positively related to a firm's innovation capability.

2.3. Relationship between knowledge acquisition and innovation capability

Different studies have defined innovation in different ways, most of which focus on the improvement or upgrading of technology, or the reform or development of products. This research considers innovation capability as the performance of the enterprise going through various types of innovation to achieve an overall improvement of its innovation capability [29]. Afuah [30] suggests that innovation should use production and marketing technology to produce new products, or services to customers, or new attributes of products to customers. However, the new attributes are related to uncertainty of competitors' behaviours. This uncertainty will influence the organizational decisions and will, in turn, affect innovation [31].

Adler and Shenhar [32] also defined innovation as: (1) the ability to develop products to meet the needs of a market, (2) the ability to use existing technology to develop products, (3) the ability to develop new products or update existing products to meet the needs of markets, and (4) the ability to acquire new technology to create new opportunities. Therefore, some authors took innovation capability as an asset in an organization. In our previous study, we extended the scope of innovation from technology to management. Liao et al. [29] measured innovation capability using three important dimensions: product innovation, process innovation and management innovation. Thus, this research proposes the third hypothesis as follows:

Hypothesis 3: Knowledge acquisition is positively related to a firm's innovation capability.

2.4. Relationship between knowledge acquisition, absorptive capacity and innovation capability

Julien et al. [33] evidenced that the organization's absorptive capacity was a significant intermediary factor in taking advantage of a weak ties networks. Frans et al. [34] concluded that absorptive capacity played a mediation role in creating new knowledge. Darroch and McNaughton [35] also found that knowledge acquisition had more indirect than direct influence on innovation. Therefore, we propose that absorptive capacity is a mediator between knowledge acquisition and innovation capability.

Hypothesis 4: Absorptive capacity is a mediator between knowledge acquisition and innovation capability.

2.5. Moderating effect of industry structure

Mariano and Pilar [21] indicated that the existence of certain industry structure-related conditions, involving technological opportunity and spillovers, will influence the level of effort put into innovation by a company, the former in a positive way, the latter negatively. This means that certain industry structures will influence the relationship between knowledge acquisition, absorptive capacity and innovation capability. Therefore, we propose the following hypothesis:

Hypothesis 5: Industry structure moderates the relationship between knowledge acquisition, absorptive capacity and innovation capability.

According to the above-mentioned studies, this study developed a research map, as shown in Figure 1. There are many complex relationships between knowledge acquisition, absorptive capacity

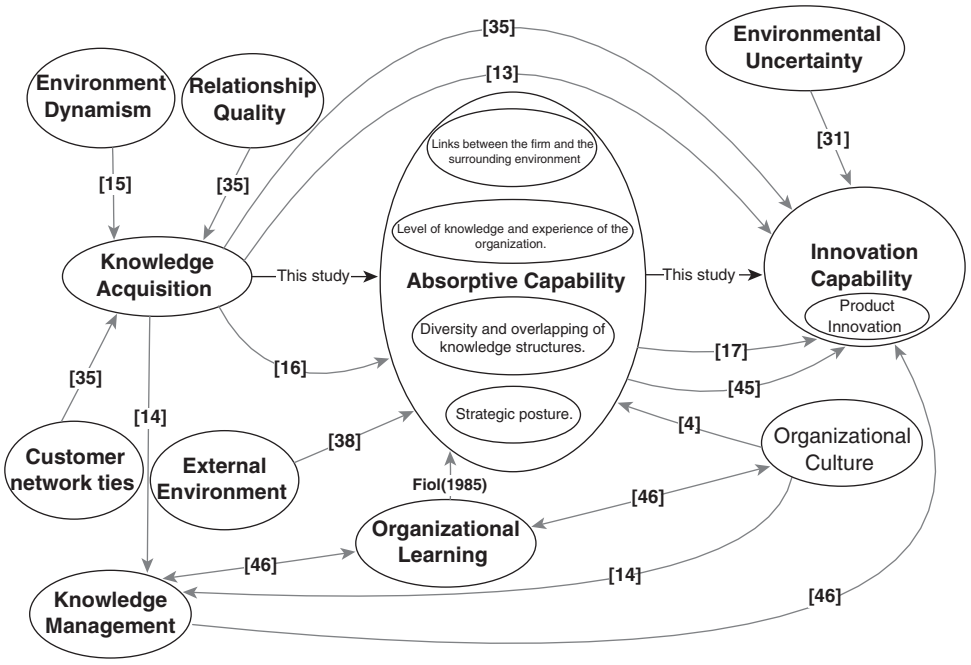

Fig. 1. Research map.

and innovation capability. The connection line in the figure indicates the main influence. In addition, we have identified some other factors affecting knowledge acquisition, absorptive capacity, and innovation capability. This presents a more comprehensive view of directions for both current and future researches.

3. Research methodology

3.1. Research framework

This study investigates the relationship between knowledge acquisition, absorptive capacity and innovation capability. According to the literature review, the research framework and hypotheses developed are depicted in Figure 2.

3.2. Sampling

This study used the cross-industry data collection method. The firms selected for empirical study were chosen from the companies listed in *Common Wealth Magazine*'s top 1000 manufacturers and top 100 financial firms in 2006. Therefore, there are two category data samples (industries) in our survey. A total of 1300 questionnaires were mailed between December 2006 and March 2007, with 362 valid and complete responses used for subsequent quantitative analysis. The useable response rate was 27.8%. Our sample distribution according to industry and gender is listed in Table 1. As can be seen, the manufacturing sector accounts for 62.7% of our sample, with the remaining 37.3% being the financial sector.

3.3. Measurement

A 5-point Likert scale (1 = totally disagree, 5 = totally agree) was used to measure these constructs. The questionnaire was further refined after a pilot study was conducted with managers in the area of knowledge management and innovation.

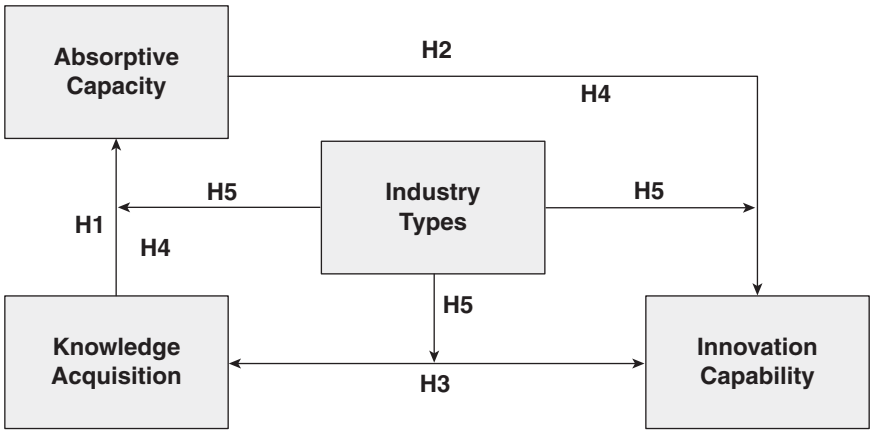

Fig. 2. Research framework.

Table 1
Percentage of samples

Demographic variable	Classification	Samples	Percentage (%)
Industry	Manufacturing	227	62.7
	Financial	135	37.3
Gender	Male	194	53.6
	Female	168	46.4
Total		362	100

3.3.1. Knowledge acquisition

Knowledge acquisition can be treated as a process of using and acquiring knowledge from existing knowledge. It requires concerted effort and a high degree of experience in recognizing and capturing new knowledge. This study modified the constructs of Gold et al. [14], Jantunen [15], and Yang et al. [13]. Thus, this research uses seven items. Two primary means for knowledge acquisition are (1) to see and acquire entirely new knowledge; or (2) create new knowledge out of existing knowledge through collaboration among individuals and business partners.

3.3.2. Absorptive capacity

On the other hand, many previous studies have measured absorptive capacity in organizations. A first approximation of the selection of factors that may be considered relevant for measuring absorptive capacity was made by Cohen and Levinthal [4]. They pointed out that in order to grasp what the sources of a firm's absorptive capacity were, one should concentrate on 'how the communications between the firm and the external environment are organized', and also on the 'nature of the know-how and experience within the organization'. This current study employs the constructs developed by Mariano and Pilar [21], which included groups of factors as follows: (1) communication with the external environment (4 items); (2) level of know-how and experience within the organization (3 items); (3) diversity and overlaps in the knowledge structure (3 items); and (4) strategic positioning (4 items).

3.3.3. Innovation capability

Our framework was developed according to the concepts of Liao et al. [29] which defined innovation capability as the performance of the enterprise going through various types of innovation to achieve an overall improvement of its innovation capability. This construct has three dimensions: (1) product innovation (6 items); (2) process innovation (4 items); and (3) management innovation (6 items).

Table 2
Descriptive statistics and correlation coefficients

Variables	Mean	SD	1	2	3	4	5	6	7	8
1. LFE	3.68	0.52	(0.60)							
2. LKE	3.69	0.56	0.54**	(0.68)						
3. DOK	3.62	0.58	0.34**	0.43**	(0.64)					
4. STP	4.28	0.47	0.37**	0.39**	0.29**	(0.45)				
5. KAC	3.83	0.45	0.42**	0.55**	0.30**	0.40**	(0.75)			
6. PRI	3.74	0.49	0.61**	0.64**	0.37**	0.48**	0.56**	(0.76)		
7. POI	3.64	0.54	0.57**	0.57**	0.39**	0.40**	0.46**	0.64**	(0.70)	
8. MAI	3.58	0.51	0.55**	0.59**	0.43**	0.41**	0.58**	0.67**	0.68**	(0.77)

Note: 1. Values in parentheses along the diagonal are alpha coefficients.
2. *$p < 0.05$, **$p < 0.01$

3.3.4. Moderate effect

It has previously been indicated that moderate effects have a significant influence on cross-sectional variations of some constructs. In this research, we also test the influence of industry type in H5.

4. Descriptive statistics and empirical results

4.1. Descriptive statistics

Means, standard deviations and reliability estimates of the study variables are presented in Table 2, which reveals that the measures exhibited appropriate internal consistency reliability. As seen in the table, almost all α are above 0.8, with some being 0.7. Cronbach [36] concluded that α above 0.7 indicates high reliability; 0.35–0.7, medium reliability; and below 0.35, low reliability; thus our reliability is quite high. Correlations reflecting several of the direct paths predicted by the hypotheses were significant.

4.2. Empirical results

4.2.1. Confirmatory factor analysis

Next, this study conducted a confirmatory factor analysis (CFA) to test the fitness of factors and items in variables, as listed in Table 3. CFI performed well with both small and large samples, with the GFI value equal to or exceeding 0.9. The SRMR value should be below 0.05, and the RMSEA value should be below 0.08. The CFI value was equal to or exceeded 0.9.

4.2.2. Convergent validity

Convergent validity can be assessed from the measurement model by determining whether each indicator's estimated pattern coefficient on its posted underlying construct factor is significant. In factor analysis, the *t*-values of all items in this research were between 5.62 and 14.77, so they all exceeded 1.96, which indicates that all observation items are significant in representing latent variables. Table 4 shows the factor loading and *t*-value of all dimensions.

4.2.3. Discriminant validity

This study tested the discriminant validity, which can be assessed for two estimated constructs by constraining the estimated correlation parameter between 0 and 1.0 and then performing a chi-square difference test on the values obtained for the constrained and unconstrained models. As seen in Table 5, the values of $\Delta\chi^2$ all exceeded 3.84, indicating that our study achieved discriminant validity.

Table 3
Fitness of CFA

Index	Variables		
	Absorptive capacity	Knowledge acquisition	Innovation capability
GFI (Goodness of Fit Index)	0.96	0.99	0.94
AGFI (Adjusted Goodness of Fit Index)	0.94	0.98	0.92
SRMR (Standardized Root Mean Square Residual)	0.042	0.025	0.04
RMSEA (Root Mean Square Error of Approximation)	0.038	0.015	0.045
NNFI (Non-Normed Fit Index)	0.97	1	0.98
CFI (Comparative Fit Index)	0.98	1	0.98
PNFI (Parsimonious Normed Fit Index)	0.73	0.59	0.81
CN (Hoelter's Critical *N*)	337.67	810.22	285.68
Normed chi-square	1.52	1.08	1.72

Table 4
Convergent validity

Variables	Dimensions	Factor loading	*t*-value
Absorptive capacity	Links between the firm and the surrounding environment (LFE)	0.46–0.59	7.98–10.4
	Level of knowledge and experience of the organization (LKE)	0.54–0.77	9.85–14.75
	Diversity and overlapping of knowledge structures (DOK)	0.45–0.56	6.94–8.37
	Strategic positioning (STP)	0.40–0.66	6.65–11.35
Knowledge acquisition	KAC	0.42–0.71	7.21–13.53
Innovation capability	Product innovation (PRI)	0.31–0.66	5.62–13.12
	Process innovation (POI)	0.47–0.73	8.6–14.77
	Management innovation (MAI)	0.53–0.66	10.01–13.28

4.2.4. Path analysis

Next, this study conducted a path analysis using the maximum likelihood (ML) estimation procedures to formally test the hypothesized relationship between the observed variables. Path analysis with ML estimation provides accurate estimates of parameter with samples between 100 and 150 [37]. Table 6 shows some important values of path analysis.

(1) Knowledge acquisition and innovation capability: According to Table 6, $\gamma_{11} = 0.42$ ($p < 0.05$), $\gamma_{12} = 0.55$ ($p < 0.05$), $\gamma_{13} = 0.30$ ($p < 0.05$), $\gamma_{14} = 0.41$ ($p < 0.05$), $\gamma_{15} = 0.21$ ($p < 0.05$), $\gamma_{16} = 0.12$ ($p < 0.05$), and $\gamma_{17} = 0.30$ ($p < 0.05$). These values were all significant, indicating that with more knowledge, organizations have greater absorptive capacity, thus supporting Hypothesis 1. As seen in Table 6 and Figure 3, $\beta_{15} = 0.31$ ($p < 0.05$), $\beta_{16} = 0.32$ ($p < 0.05$), $\beta_{17} = 0.25$ ($p < 0.05$), $\beta_{25} = 0.30$ ($p < 0.05$), $\beta_{26} = 0.26$ ($p < 0.05$), $\beta_{27} = 0.22$ ($p < 0.05$), $\beta_{35} = 0.04$ ($p > 0.05$), $\beta_{36} = 0.12$ ($p < 0.05$), $\beta_{37} = 0.15$ ($p < 0.05$), $\beta_{45} = 0.17$ ($p < 0.05$), $\beta_{46} = 0.12$ ($p < 0.05$), and $\beta_{47} = 0.08$ ($p > 0.05$). These values were all significant, except $\beta_{35} = 0.04$ ($p > 0.05$) and $\beta_{47} = 0.08$ ($p > 0.05$), indicating that with greater absorptive capacity, organizations will have greater innovation capability, with the exception of some paths (β_{35}, β_{47}), thus giving partial support to Hypothesis 2.

(2) Knowledge acquisition and innovation capability: According to Table 6, the relationships between knowledge acquisition, product innovation, process innovation and management innovation were statistically significant ($\gamma_{15} = 0.21$ ($p < 0.05$), $\gamma_{16} = 0.12$ ($p < 0.05$), $\gamma_{17} = 0.30$ ($p < 0.05$)). Therefore, knowledge acquisition is positively related to a firm's innovation capability, as predicted in Hypothesis 3.

Table 5
Discriminant validity

Variables	Models	χ^2	df	$\Delta\chi^2$	Δdf
Absorptive capacity	1. Unconstrained models	108.01	71	–	–
	2. LKE-LFE	118.68	72	10.67*	1
	3. DOK-LFE	128.88	72	20.87*	1
	4. STP-LFE	170.01	72	62*	1
	5. DOK-LKE	121.02	72	13.01*	1
	6. STP-LKE	190.31	72	82.3*	1
	7. STP-DOK	143.49	72	35.48*	1
Innovation capability	1. Unconstrained models	174.33	101	–	–
	2. POI-PRI	200.01	102	25.68*	1
	3. MAI-PRI	203.39	102	29.06*	1
	4. MAI-POI	189.53	102	15.2*	1

Note 1: $\Delta\chi^2$ = the constrained model; χ^2 = the unconstrained model.
Note 2: * Significant, if $\Delta\chi^2 > 3.84$.

Table 6
Path analysis

Path	Relation	Standard solution	Result
KAC→LFE(γ_{11})	+	0.42***	Supported
KAC→LKE(γ_{12})	+	0.55***	Supported
KAC→DOK(γ_{13})	+	0.30***	Supported
KAC→STP(γ_{14})	+	0.41***	Supported
Supporting H1			
LFE→PRI(β_{15})	+	0.31***	Supported
LFE→POI(β_{16})	+	0.32***	Supported
LFE→MAI(β_{17})	+	0.25***	Supported
LFE→PRI (β_{25})	+	0.30***	Supported
LFE→POI (β_{26})	+	0.26***	Supported
LFE→MAI (β_{27})	+	0.22***	Supported
DOK→PRI (β_{35})	–	0.04	–
DOK→POI (β_{36})	+	0.12**	Supported
DOK→MAI (β_{37})	+	0.15***	Supported
STP→PRI (β_{45})	+	0.17***	Supported
STP→POI (β_{46})	+	0.12**	Supported
STP→MAI (β_{47})	–	0.08	–
Partially supporting H2			
KAC→PRI(γ_{15})	+	0.21***	Supported
KAC→POI(γ_{16})	+	0.12**	Supported
KAC→MAI(γ_{17})	+	0.30***	Supported
Supporting H3			

Note 1: *$p < 0.05$; ** $p < 0.01$; ***$p < 0.001$.
Note 2: +: positive; –: insignificant.

(3) Mediator effect – absorptive capacity: From Table 7 and Figure 4, the model fit of our fully mediated model indicated that χ^2 (33, n = 362) = 55.36, $p < 0.01$; GFI = 0.97; CFI = 0.99; and RMSEA = 0.043. Both of the estimated structural paths are significant. The partially mediated model fits the data: χ^2 (32, n = 362) = 55.35, $p < 0.01$; GFI = 0.97; CFI = 0.99; and RMSEA = 0.045, although the path between knowledge acquisition and innovation capability is not significant. A direct model for the data is: χ^2 (33, n = 362) = 95.38, $p < 0.01$; GFI = 0.95; CFI = 0.98; and RMSEA = 0.072. In comparing the fit of the three models, using GFI, CFI and RMSEA, the results suggest the partially mediated model and fully mediated model provide substantially better fit to the data than the

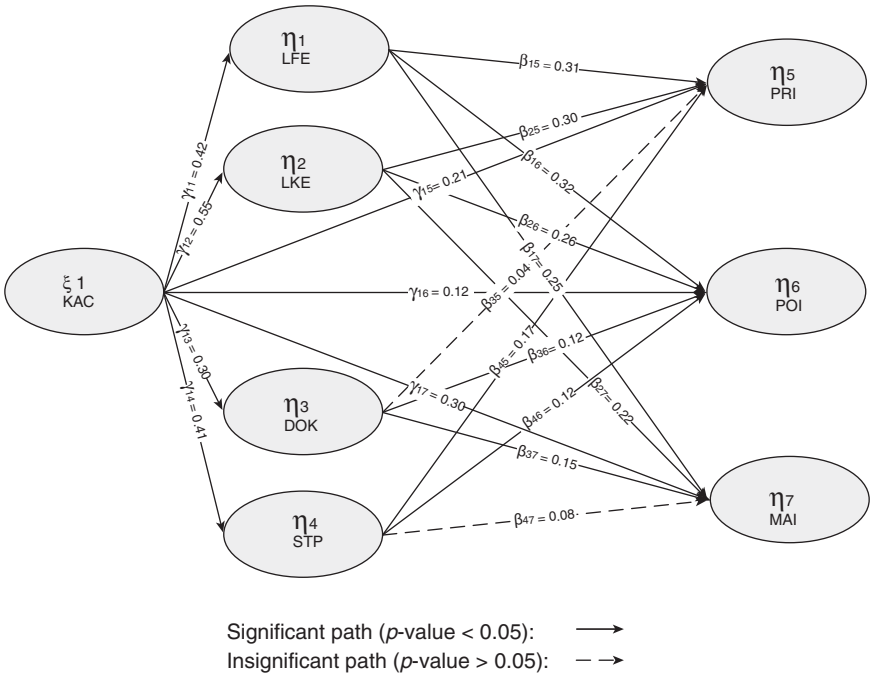

Fig. 3. Optimal path diagram.

direct model. Furthermore, the results of a chi-square difference test demonstrated that the partially mediated model and fully mediated model were non-significant (χ^2 diff (1, n = 362) = 0.01, $p > 0.05$). Therefore, the fully mediated model is the best model in our study. Secondly, we use three steps to show our model is a fully mediated one. First, we examine the relationship between knowledge acquisition and innovation capability, and the results are significant ($\beta = 0.78$, $p < 0.01$). Second, we consider the relation of absorptive capacity and innovation capability, and the results are also significant ($\beta = 0.98$, $p < 0.01$). Third, we add absorptive capacity to the first model to test if absorptive capacity is a mediator. The results of the partially mediated model indicate that, once we added absorptive capacity to our model as a mediator, the relationship between knowledge acquisition and innovation capability changed to non-significant ($\beta = 0.02$, $p > 0.05$). Originally, the total effect between knowledge acquisition and innovation capability was 0.78, but now it is mostly equal to the direct effect of 0.02 plus the indirect effect of 0.776 (0.8*0.97) between knowledge acquisition and innovation capability. This means that the total effect between knowledge acquisition and innovation capability is totally partial out by absorptive capacity after it is added to our model. These results demonstrate that absorptive capacity is a mediator in our model and fully mediated is the best one. Absorptive capacity therefore fully mediated the relationship between knowledge acquisition and innovation capability, supporting Hypothesis 4.

(4) Moderator analysis: In order to test the moderator effect, we divided the samples into manufacturing firms (M sectors) and financial firms (F sectors). Table 8 shows that the completely mediating model was the best model for both manufacturing firms and financial firms.

For all samples, the results of path analysis showed that some paths are not significant. Table 9 shows that in the MΛ, MΛΘ, MΛΘBΓ model, $\Delta\chi^2$ s are significant ($p < 0.05$). This means that in the M and F groups there are different factor loadings. Furthermore, we tested different factor loadings in different groups. Table 10 compares the two different groups in the same dimension. Two dimensions were significantly different. Also, there was only one path significantly different in these two groups ($\Delta\chi^2$ was 23.27*).

Table 7
Test for mediator effect

	χ^2 (df)	GFI	AGFI	RMSEA	NNFI	CFI	PNFI	CN	Normed chi-square
Partially mediating	55.35(32)	0.97	0.95	0.045	0.99	0.99	0.7	339.09	1.73
Direct path	55.35(32)	0.97	0.95	0.045	0.99	0.99	0.7	339.09	1.73
Fully mediating	55.36(33)	0.97	0.95	0.043	0.99	0.99	0.72	347.08	1.67

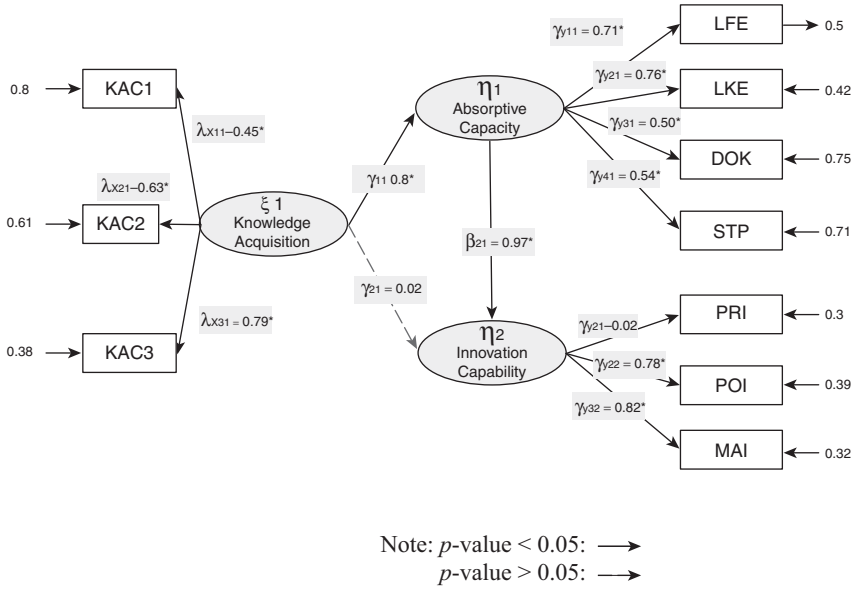

Fig. 4. Secondary CFA.

Table 8
Manufacturing sectors fit index

Completely mediating model	χ^2 (df)	GFI	AGFI	RMSEA	NNFI	CFI	PNFI	CN	Normed chi-square
Manufacturing sectors	62.49(33)	0.95	0.91	0.063	0.97	0.98	0.71	187.86	1.89
Financial sectors	40.27(33)	0.94	0.91	0.041	0.98	0.98	0.69	167.27	1.22

This study found that the industry type indeed had a moderating effect in the relationship between knowledge acquisition, absorptive capacity and innovation capability. In other words, different industries will have different effects in knowledge acquisition, absorptive capacity and innovation capability, as predicted in Hypothesis 5.

In manufacturing firms, knowledge acquisition does not significantly affect process innovation, while the links between the firm and its surrounding environment do not significant affect management innovation. On the contrary, in financial firms, knowledge acquisition does not significantly affect product innovation and process innovation, while the level of knowledge and experience of the organization does not significantly affect process innovation and management innovation.

This study found that financial sectors were regularly constrained by the Financial Supervisory Commission of Taiwan's Executive Yuan. Therefore, there is less innovation capability in financial sectors than manufacturing ones. But, in manufacturing sectors, absorptive capability does not

Table 9
Test for structure equivalence

Model	χ^2	df	$\Delta\chi^2$	Δdf	RMSEA	NNFI	CFI
M Form	102.76	66	0	0	0.056	0.98	0.98
MΛ	123.84	73	21.08*	7	0.062	0.97	0.98
MΛΘ	184.75	83	60.71*	10	0.083	0.95	0.95
MΛΘBΓ	212.05	85	27.3*	2	0.091	0.94	0.95
MΛΘBΓΨ	212.73	87	0.68	2	0.090	0.94	0.95
MΛΘBΓΨΦ	212.78	88	0.05	1	0.089	0.95	0.95

Note: *$p < 0.05$.

Table 10
Test for factor load equivalence

Model	χ^2	df	$\Delta\chi^2$	Δdf
Mform	102.76	66	0	0
Mform λ1 LFE	110.97	67	8.21*	1
Mform λ2 LKE	102.86	67	0.1	1
Mform λ3 DOK	108.83	67	6.07*	1
Mform λ4 STP	103.10	67	0.34	1
Mform λ5 KAC1	105.59	67	2.83	1
Mform λ6 KAC 2	103.56	67	0.8	1
Mform λ7 KAC 3	103.14	67	0.38	1
Mform λ8 PRI	103.98	67	1.22	1
Mform λ9 POI	103.37	67	0.61	1
Mform λ10 MAI	103.65	61	0.89	1

Note: *$p < 0.05$.

affect innovation capability positively. This indicates that industry does have a moderating effect between knowledge acquisition, absorptive capacity and innovation capability. However, there should be further research defining the relationship between knowledge acquisition and innovation capability.

4.3 Research findings

This study investigates the roles of knowledge absorptive capacity, knowledge acquisition and innovation capability in finance and manufacturing. We found that absorptive capacity is a mediator between knowledge acquisition and innovation capability. Our statistical analyses yield the following findings (Table 11):

1. Knowledge acquisition is positively related to absorptive capabilities. Hence, H1 is supported. According to this, organizations can acquire knowledge and information to increase their absorptive capacity.
2. Absorptive capacity is positively related to a firm's innovation capability. Among the four dimensions of absorptive capacity, only the level of knowledge and experience of the organization have no positive influence on product innovation. Therefore, H2 is partially supported.
3. Knowledge acquisition is positively related to a firm's innovation capability. Thus, H3 is supported.
4. Absorptive capacity indeed plays a mediator role between knowledge acquisition and innovation capability. Thus, H4 is supported.
5. Models in financial and manufacturing sectors yield different results, showing that industry structure moderates the relationship between knowledge acquisition, absorptive capacity, and innovation capability. Hence, H5 is supported.

Table 11
Summary of research hypotheses

	Hypothesis	Result	Descriptions
H1	Knowledge acquisition is positively related to absorptive capabilities	Supported	–
H2	Absorptive capacity is positively related to a firm's innovation capability	Partially supported	Only level of knowledge and experience of organization have no positive influence on product innovation
H3	Knowledge acquisition is positively related to a firm's innovation capability	Supported	–
H4	Absorptive capacity is a mediator between knowledge acquisition and innovation capability	Supported	–
H5	Industry structure moderates the relationship between knowledge acquisition, absorptive capacity, and innovation capability	Supported	There are different paths between different industries

5. Conclusion

5.1. Discussion

In this article, the authors implemented four dimensions that are used to measure absorptive capacity. Combining the absorptive capacity, internal operation employee behaviours and organization policy is more complete. Therefore, absorptive capacity is not only related to employee behaviours but also to the organization overall. This is more comprehensive than the findings of Zahra and George [16] that absorptive capacity influences only employee behaviours.

This study demonstrates the influence on knowledge acquisition and innovation capability. Yang et al. [13] found knowledge acquisition to be positively related with innovation capability, but Darroch and McNaughton [35] argued that knowledge acquisition is indirectly influenced by innovation capability. Thus, how knowledge acquisition can affect innovation capability is the key issue of this work. Julien et al. [33] proved that absorptive capacity and network are mediators to innovation capability, and this study supports their results that absorptive capacity is an intermediary. In addition, this study found knowledge acquisition affects innovation by absorptive capacity.

According to Yang et al. [13], managers should set up knowledge management processes that are appropriate for acquiring knowledge by organizational learning. Moreover, they should build an environment appropriate for sharing employees' tacit knowledge in the organization. Briefly speaking, an organization should build up its absorptive capacity mechanism. In particular, Liao et al. [38] used innovation capability, including management innovation, and found that the relationship between absorptive capacity and innovation capability is related not only to employees but also management of the organization.

5.2. Implications

This study shows that knowledge acquisition could affect innovation capability indirectly. This does not mean that knowledge is unimportant, but that the relationship of knowledge acquisition, absorptive capacity and innovation capability is more critical for managers. In other words, with a powerful absorptive capacity, knowledge acquisition could successfully increase innovation capability beyond that of a firm's competitors. Liao et al. [29] argued that knowledge sharing and absorptive capacity would be more connected by absorptive capacity. In addition, Ouyang [39] considered

that firms' absorptive capacity gains from knowledge transfer in technology sourcing and verified how a firm matches a sourcing mode with its absorptive capacity to enhance knowledge transfer in technology sourcing. Thus, knowledge acquisition, knowledge transfer, or absorptive capacity will be more meaningful to a firm and its employees when supported by absorptive capacity.

Because the knowledge of an organization is developed progressively, absorptive capacity must be related to existing knowledge, including its experience and structure. Therefore, different existing knowledge will also have different distortions of the absorption of new knowledge. Mariano and Pilar [21] found that different outside environments or industry sectors have different impacts on absorptive capacity. In Asia, because of financial crises, governments have asked banks to take some measures to stop these crises. These measures would increase bank risk, add guarantees, and reduce the value of real estate holdings, leading banks to face stronger competitive challenges. Also, two different industry sectors have different knowledge structures. The absorption of knowledge in an organization is promoted because of diversification of knowledge [21]. The same backgrounds of knowledge increase its flows and the differences help identify individuals.

What we call sustaining innovation is producing better products or service for customers in order to create more profits, whereas disruptive innovation tries to produce products that are more convenient and easy for customers to use in order to save cost. Therefore, most innovation is related with products. No doubt most research about innovation is involved with marketing issues (including leaders and challengers in markets.) But for organizations, they also put more concerns not only on general value-added activities (logistics, R&D, manufacturing, and customer service) but also on technology analysis such as reconfirming decision support and operations. In other words, organizations use marketing research, analysis markets reports, and predictions of market needs and financial conditions. These are not directly related with products or technology. Thus, based on existing knowledge in organizations, organizations can increase innovation. Innovation capability not only focuses on products or technology, but also on process and management.

In addition, the market position relates to the situation where an established product/service produced by an established process is introduced to a new context; here the innovation management challenge is concerned with issues like adoption behaviour and technology transfer. Business model innovation relates to the situation in which a reframing of the current product/service, process and market context results in seeing new challenges and opportunities and letting go of others. Each of these poses challenges for the ways in which innovation are organized and managed, called the term of innovation management capability [40]. In addition, the degree of innovation management implementation has an essential impact on the two competitiveness dimensions including technological innovation and differentiation [41]. Thus, this study considers that knowledge acquisition and absorptive capacity could be knowledge resources to strengthen innovation management capability on adoption behaviour and technology transfer.

On the other hand, based on resource-based theory, an organization should build on core competitiveness to maintain its competitive advantage. For a sustainable run of enterprises, any organization should create innovation capability. If we consider organization as an organic system, then knowledge is its input, absorptive capacity is a kind of processing, and innovation capability is its output. Thus, by acquiring knowledge, organizations absorb knowledge and transfer it to innovation capability so that firms can obtain competitive advantage [38, 42–43].

Using case studies drawn from three different sectors of an organization, Easterby-Smith et al. [44] argue that a process perspective on absorptive capacity should include the role of power in the way knowledge is absorbed by organizations, and provide a better understanding of the nature of boundaries within and around organizations. This article argues that this limited development results from the dominance of quantitative studies which have failed to develop insights into the processes of absorptive capacity, and builds on recent qualitative studies which have successfully opened up new perspectives. Thus, both quantitative and qualitative approaches are necessary methodologies for broadening the research horizon of absorptive capacity.

5.3. Future works

In this study, we consider industry as a moderator. But we do not know whether or not organizational culture influences innovation capability. This is another moderator in organizations, which would be a topic for further research in the future.

Cohen and Levinthal [4] found that there is a relationship between absorptive capacity and the learning capability. Therefore, organizational culture may play an important role as a moderator. Organizational culture is not only a set of values, but also an attitude/behaviour of members in an organization. For this reason, organizational culture can be treated as an antecedent of absorptive capacity in future works.

Thuc Anh et al. [45] found that absorptive capacity does influence knowledge acquisition. Knowledge acquisition is a full mediator between absorptive capacity and performance. In addition, this study found absorptive capacity is a mediator for another two variables. This infers that knowledge acquisition is a key issue for innovation in future work. On the other hand, Chou found that research partnerships expand a firm's absorptive capacity [46]. Thus, different formats and source of knowledge might be alternative variables for testing in future research.

Chin-Loy [47] found organizational learning could promote knowledge management, which means that we can acquire knowledge by organizational learning in order to develop absorptive capacity. Therefore, organizational learning is another important issue for knowledge management and innovation capability [48–49]. For example, García-Morales et al. [50] proposed a global model to analyse how technology absorptive capacity and technology proactivity influence organizational learning and innovation, and how these dynamics capabilities affect organizational performance. The model also shows how organizational learning affects organizational innovation in Spanish technological firms.

More antecedents of potential absorptive capacity and its impact on innovation performance should be explored at future works [51]. More statistical methods for analysis could be considered for alternative hypothesized models based on the literature.

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